

## BOTH-SIDE RECORDING APPARATUS

### BACKGROUND OF THE INVENTION

#### Field of the Invention

5           The present invention relates to a both-side recording apparatus capable of both-side recording on a recording sheet of which front side and back side are inverted by a sheet inverting unit, and also to a both-side recording apparatus provided with a sheet  
10 feeding roller, a recording unit and a sheet inverting unit.

#### Description of the Related Art

          For automatic both-side recording in an ink jet recording apparatus, several methods have been  
15 commercialized or proposed in several methods. In these methods, after recording on a front side (top side) of a recording sheet, the conveying direction thereof is reversed to feed the recording sheet into a front-back side inverting apparatus, and, after an  
20 inverting operation, the recording sheet is conveyed again by the same sheet conveying unit to execute recording on the back side of the recording sheet by the same recording unit.

          Among these methods, USP No. 6,332,068  
25 discloses an invention in which the front-back side inverting apparatus is provided at an upstream side of a sheet conveying roller and the conveying

direction of the recording sheet is inverted by 180°  
by two inverting rollers positioned above and below.  
Also Japanese Patent Application Laid-open No. 2002-  
067407 discloses an invention in which the front-back  
5 side inverting apparatus is provided at an upstream  
side of a sheet conveying roller and the conveying  
direction of the recording sheet is inverted by 180°  
by a roller of a large diameter, principally  
executing the inversion, and an auxiliary roller of a  
10 small diameter.

However, these prior examples have been  
associated with certain limitations.

In the invention disclosed in USP No. 6,332,068,  
since a sheet conveying path to the front-back side  
15 inverting apparatus is not present on an extension of  
a sheet conveying path connecting the sheet conveying  
roller and a sheet feeding roller, a recording medium  
of a large thickness or a high rigidity cannot be  
passed to the sheet conveying path to the front-back  
20 side inverting apparatus.

Also in the invention disclosed in Japanese  
Patent Application Laid-open No. 2002-067407, the  
sheet conveying path to the front-back side inverting  
apparatus is present approximately on an extension of  
25 the sheet conveying path connecting a sheet discharge  
roller and the sheet conveying roller but has a  
meandering shape, so that a recording medium of a

large thickness or a high rigidity cannot be passed to the sheet conveying path to the front-back side inverting apparatus as in the above-described case. Also the rollers of the front-back side inverting  
5 apparatus are concentrated above the sheet conveying path connecting the sheet discharge roller and the sheet conveying roller, so that the dimension of the apparatus has to be made large in order to secure a necessary length for the sheet conveying path.

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#### SUMMARY OF THE INVENTION

An object of the present invention is to provide a both-side recording apparatus of a simple configuration without an increase in the dimension of  
15 the apparatus, capable of passing a recording medium of a large thickness or a high rigidity in a state where a sheet inverting apparatus is mounted, thereby enabling to improve the operability.

Another object of the present invention is to  
20 provide a both-side recording apparatus provided with a sheet conveying roller, a recording unit and a sheet inverting unit, the apparatus including a first sheet path extending from the sheet conveying roller to the sheet inverting unit and returning again to  
25 the sheet conveying roller, and a second sheet path extended substantially linearly at an upstream side of the sheet conveying roller, wherein the first

sheet path and the second sheet path mutually share a part in common.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5           Fig. 1 is a schematic perspective view showing an entire configuration of a both-side recording apparatus constituting an embodiment of the present invention;

10           Fig. 2 is a schematic lateral cross-sectional view showing an entire configuration of the both-side recording apparatus constituting an embodiment of the present invention;

15           Fig. 3 is a schematic perspective view showing a pinch roller contact-separation mechanism in an both-side recording apparatus of an embodiment of the present invention;

20           Figs. 4A, 4B and 4C are schematic lateral cross-sectional views showing a pinch roller contact-separation mechanism in a both-side recording apparatus of an embodiment of the present invention;

            Figs. 5A and 5B are schematic lateral cross-sectional views showing a PE sensor vertical-movement mechanism in a both-side recording apparatus of an embodiment of the present invention;

25           Figs. 6A and 6B are schematic lateral cross-sectional views showing a sheet guide vertical-movement mechanism in a both-side recording apparatus

of an embodiment of the present invention;

Fig. 7 is a schematic perspective view showing a guide shaft vertical-movement mechanism in a both-side recording apparatus in an embodiment of the present invention;

Figs. 8A, 8B and 8C are schematic lateral cross-sectional views showing a guide shaft vertical-movement mechanism in a both-side recording apparatus of an embodiment of the present invention;

Fig. 9 is a schematic perspective view showing a life cam shaft drive mechanism in a both-side recording apparatus in an embodiment of the present invention;

Figs. 10A, 10B, 10C and 10D are schematic lateral cross-sectional views showing states in different positions of a lift mechanism in a both-side recording apparatus of an embodiment of the present invention;

Fig. 11 is a timing chart showing operations states of the lift mechanism in the both-side recording apparatus of an embodiment of the present invention;

Figs. 12A, 12B and 12C are schematic lateral cross-sectional views showing back-feed starting states (reconveying state) for a recording medium in a both-side recording apparatus of an embodiment of the present invention;

Fig. 13 is a schematic lateral cross-sectional view showing a configuration of an auto both-side unit (auto inverting unit, sheet inverting unit) in a both-side recording apparatus in an embodiment of the present invention;

Figs. 14A and 14B are schematic lateral cross-sectional views showing function of a flap in the auto both-side unit of a both-side recording apparatus in an embodiment of the present invention;

Fig. 15 is a schematic lateral cross-sectional view showing an auto both-side unit driving mechanism of a both-side recording apparatus in an embodiment of the present invention;

Figs. 16A, 16B, 16C, 16D, 16E and 16F are schematic lateral cross-sectional views showing, in sequence, function states of the auto both-side unit driving mechanism of the both-side recording apparatus in an embodiment of the present invention;

Figs. 17A, 17B, 17C, 17D and 17E are schematic lateral cross-sectional views showing, in sequence, other function states of the auto both-side unit driving mechanism of the both-side recording apparatus in an embodiment of the present invention;

Figs. 18A, 18B and 18C are schematic lateral cross-sectional views showing a front end registration operation for a back side in case of using a thin recording sheet in a both-side recording

apparatus of an embodiment of the present invention;

Figs. 19A, 19B and 19C are schematic lateral cross-sectional views showing a front end registration operation for a back side in case of  
5 using a thick recording sheet in a both-side recording apparatus of an embodiment of the present invention;

Figs. 20A and 20B are combined as shown in Fig. 20, and they are flow charts showing a sequence of an  
10 auto both-side recording operation in a both-side recording apparatus of an embodiment of the present invention;

Fig. 21 is a schematic block diagram showing a control circuit configuration of a both-side  
15 recording apparatus in an embodiment of the present invention; and

Fig. 22 is a schematic lateral cross-sectional view showing another configuration of the auto both-side unit in a both-side recording apparatus of an  
20 embodiment of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, there will be given a detailed explanation on the embodiments of the  
25 present invention with reference to accompanying drawings. Throughout the drawings, like numbers indicate same or equivalent parts.

Fig. 1 is a schematic perspective view showing an entire configuration of an embodiment of the both-side recording apparatus in which the present invention is applied, and Fig. 2 is a schematic lateral cross-sectional view showing an entire configuration of the both-side recording apparatus of the embodiment seen from a direction A in Fig. 1. Figs. 1 and 2 illustrate a case where the recording apparatus is an ink jet recording apparatus for executing recording on a recording medium by discharging ink. In the following description, a term "recording sheet" or "sheet" may be used instead of a wider term "recording medium" because the recording sheet is a representative example of the recording medium, but such use does not intend to limit the range of the recording medium to the sheet (recording sheet).

Referring to Figs. 1 and 2, there are shown a main body 1 of a recording unit, an auto both-side unit (sheet inversion unit, auto inversion unit) 2, a chassis 10 supporting the structure of the recording unit main body 1, a recording head 11 for executing recording by ink discharge, an ink tank 12 storing ink to be supplied to the recording head 11, a carriage 13 for supporting the recording head 11 and the ink tank 12 and executing a scanning (main scan) motion, a guide shaft 14 for guiding and supporting



the carriage 13, a guide rail 15 provided parallel to the guide shaft 13, for guiding and supporting the carriage 13, a carriage belt (timing belt) 16 for driving the carriage 13, a carriage motor 17 for driving the carriage belt 16 by a pulley, a code strip 18 for detecting a position of the carriage 13, and an idler pulley 20 positioned in an opposed relationship to the pulley of the carriage motor 17 for supporting the carriage belt 16 under a tension.

10        There are also shown a sheet conveying roller 21 for conveying a recording sheet, a pinch roller 22 pressed to and driven by the sheet conveying roller 21, a pinch roller holder 23 for rotatably supporting the pinch roller 22, a pinch roller spring 24 for pressing the pinch roller 22 to the sheet conveying roller 21, a sheet conveying roller pulley 25 fixed to the sheet conveying roller 21, an LF motor 26 for driving the sheet conveying roller 21, a code wheel 27 for detecting a rotation angle of the sheet conveying roller 21, and a platen 29 for supporting the recording sheet in an opposed relation to the recording head 11.

25        There are further shown a first sheet discharge roller 30 for conveying the recording medium in cooperation with the sheet conveying roller 21, a second sheet discharge roller 31 provided at a downstream side of the first sheet discharge roller

30, a first spur train 32 constituting a rotary member for supporting the recording sheet in an opposed relation to the first sheet discharge roller 30, a second spur train 33 constituting a rotary member for supporting the recording sheet in an opposed relation to the second sheet discharge roller 31, a spur base 34 for rotatably supporting the first spur train 32 and the second spur train 33, a maintenance unit 36 to be operated for preventing clogging of the recording head 11 (clogging of discharge ports or nozzles) thereby recovering the ink discharge performance and for filling the ink in ink flow paths of the recording head at a replacement of the ink tank 12, and a main ASF (auto sheet feeder) 37 constituting an auto sheet feeding unit for stacking recording sheets and supplying the recording sheet one by one to the recording unit at a recording operation.

In Figs. 1 and 2, there are also shown an ASF base 38 constituting a base of the main ASF 37, a sheet feeding roller 39 maintained in contact with the stacked recording sheets for feeding thereof, a separation roller 40 for separating recording sheets one by one in case they are simultaneously fed, a pressure plate 41 for stacking the recording sheets and biasing them toward the sheet feeding roller 39, a side guide 42 provided on the pressure plate 41 and

fixable in an arbitrary position in a transversal direction of the recording sheet, a returning claw 43 for returning, to predetermined position, a front end of a recording sheet which is advanced beyond a nip  
5 portion of the sheet feeding roller 39 and the separation roller 40 at a sheet feeding operation, and an ASF flap 44 for limiting a sheet passing direction of the recording sheet from the main ASF 37 to a single direction.

10           There are further shown a lift input gear 50 meshing with an ASF planet gear 49, a lift reducing gear train 51 for transmitting under reduction a power of the lift input gear 50, a lift cam gear 52 connected directly to a lift cam shaft, a guide shaft  
15 spring 55 for biasing the guide shaft 14 toward a direction, a guide slope face 56 on which a cam of a guide shaft gear 53 slides, a lift cam shaft 58 for lifting the pin roller holder 23 etc., a sheet guide 70 for guiding the front end of the recording sheet  
20 to the nip portion between the sheet conveying roller 21 and the pinch roller 22, a base 72 for supporting the entire recording unit 1, and a control board 301 constituting a control unit.

Fig. 21 is a block diagram showing control  
25 means for driving the entire recording apparatus in which the present invention is applied. Referring to Fig. 21, there are provided a CR (carriage) encoder

sensor 19 for reading the code strip provided on the carriage 13, an LF encoder sensor 28 for reading the code wheel 27 mounted on the chassis 1, an ASF motor 46 for driving the main ASF 37, a PE sensor 67 for  
5 detecting the function of a PE sensor lever 66, a lift cam sensor 69 for detecting the function of the lift cam shaft 58, and a both-side unit sensor 130 for detecting a mounted or detached state of the auto both-side unit 2.

10 In Fig. 21, there are further provided a PG motor 302 for driving the maintenance unit 36, a PG sensor 303 for detecting the function of the maintenance unit 36, an ASF sensor 305 for detecting the function of the main ASF 37, a head driver 307  
15 for driving the recording head 11, a host apparatus 308 for transmitting recording data to the present recording apparatus, an I/F (interface) for electrical connection between the host apparatus 308 and the present recording apparatus, a CPU 310 for  
20 issuing a control command thereby controlling the present recording apparatus, a ROM 311 storing control data etc., and a RAM 312 serving as an area for developing recording data etc.

Now there will be given, with reference to Figs.  
25 1, 2 and 21, explanations on the outline of the recording apparatus of the present invention and then on functions of constituent units. At first there

will be explained a configuration of a general recording apparatus of a serial scanning type. The recording apparatus of the present embodiment is principally constituted of a sheet feeding unit, a  
5 sheet conveying unit, a recording unit, a recording head maintenance unit and an auto inversion unit (auto both-side unit). When recording data are transmitted from the host apparatus 308 and stored in the RAM 312 through the interface (I/F) 309, the CPU  
10 310 issues a recording operation start command to initiate a recording operation.

When the recording operation is initiated, a sheet feeding operation is executed at first. The main ASF corresponds to the sheet feeding unit. The  
15 sheet feeding unit is constituted of an auto sheet feeding unit for extracting one by one the plural recording sheets stacked on the pressure plate 41, for supply to the sheet conveying unit. At the start of the sheet feeding operation, the ASF motor 46  
20 rotates in a forward direction to rotate a cam supporting the pressure plate 41 through a gear train. When the cam is detached by the rotation of the ASF motor 46, the pressure plate 41 is biased, by the function of an unillustrated pressure plate spring,  
25 toward the sheet feeding roller 39. At the same time, the sheet feeding roller 39 rotates in a conveying direction of the recording sheet, thereby starting

the conveying of an uppermost recording sheet. In this operation, plural recording sheets may be advanced at the same time depending on conditions of a frictional force between the paper feeding roller 39 and the recording sheet and of a mutual frictional force between the recording sheets.

In such situation, the separation roller 40 maintained in contact with the sheet feeding roller 39 and having a predetermined inverse rotation torque in a direction opposite to the conveying direction of the recording sheet serves to push back the recording sheet onto the pressure plate other than the recording sheet closest to the side of the sheet feeding roller 39. Also at the end of the sheet feeding operation by the ASF, the separation roller 40 is released from the contact state with the sheet feeding roller 39 and is separated therefrom by a predetermined distance by a cam function, and, in this state, the returning claw 43 is rotated to perform its function of securely returning the recording sheet onto the predetermined position on the pressure plate. Through the aforementioned operations, only one recording sheet is conveyed to the sheet conveying unit.

When the one recording sheet is conveyed from the main ASF 37, the front edge of the recording sheet comes into contact with the ASF flap 44 biased

by the ASF flap spring in a direction to block the sheet path, but the front edge passes by pushing back the ASF flap 44. When the recording operation on the recording sheet is completed and the rear edge of the recording sheet passes the ASF flap 44, the ASF flap 44 returns to the original biased state to close the sheet path, whereby the recording sheet does not return to the side of the main ASF 37 when conveyed in the reverse direction.

10           The recording sheet conveyed from the sheet feeding unit is conveyed to the nip portion of the sheet conveying roller 21 and the pinch roller 22, constituting sheet conveying unit. As the center of the pinch roller 22 is mounted with a certain offset, with respect to the center of the sheet conveying roller 21, in a direction closer to the first sheet discharge roller 30, whereby a tangential direction along which the recording sheet is inserted is somewhat inclined from the horizontal direction.

15           Therefore, in order that the front edge of the sheet can be securely guided to the nip portion, the recording sheet is conveyed with an angle formed by a sheet path formed by the pinch roller holder 23 and the guide member (sheet guide) 70.

20           The sheet conveyed by the ASF37 impinges on the nip portion of the sheet conveying roller 21 which is in a stopped state. In this operation, the main ASF

37 executes a conveying of a distance somewhat longer than the predetermined sheet path length, whereby a loop is formed in the sheet between the sheet feeding roller 39 and the sheet conveying roller 21. A  
5 returning force of the loop to a straight state pushes the front edge of the sheet toward the nip portion of the sheet conveying roller 21, whereby the front edge of the sheet is aligned parallel to the sheet conveying roller 21, thereby achieving so-  
10 called registration operation. After such registration operation, the rotation of the LF motor 26 is initiated in a normal advancing direction of the recording sheet (direction advancing toward the first sheet discharge roller 30). Thereafter the  
15 sheet feeding roller 39 is cut off from the driving power and is rotated by the movement of the recording material. At this point, the recording sheet is conveyed only by the sheet conveying roller 21 and the pinch roller 22. The recording sheet advanced in  
20 the normal direction by a predetermined line feed amount, and proceeds along a rib provided on the platen 29.

The front edge of the recording sheet reaches in succession a nip portion between the first sheet  
25 discharge roller 30 and the first spur train 32 and a nip portion between the second sheet discharge roller 31 and the second spur train 33, but the first sheet



discharge roller 30 and the second sheet discharge roller 31 have peripheral speeds substantially equal to that of the sheet conveying roller 21 and the first sheet discharge roller 30 and the second sheet discharge roller 31 are connected with the sheet conveying roller 21 through a gear train to rotate the first sheet discharge roller 30 and the second sheet discharge roller 31 in synchronization with the sheet conveying roller 21, whereby the recording sheet is conveyed without a slack or a tension.

The recording unit is principally composed of the recording head 11 constituting recording means for recording on the recording sheet based on recording data, and the carriage 13 supporting the recording head 11 and executing a scanning (movement) in a direction crossing (usually perpendicularly) the conveying direction of the recording sheet. The carriage 13 is guided and supported by the guide shaft fixed to the chassis 10 and the guide rail 15 constituting a part of the chassis 10, and is reciprocated by the transmission of a driving force of the carriage motor 17 through the carriage belt 16, supported under tension between the carriage motor 17 and the idler pulley 20.

The recording head 11 is provided with plural ink flow paths connected to the ink tank 12, and the ink flow paths communicate with discharge ports

provided on a face (discharge port face) opposed to the platen 29. In the interior of each of the plural discharge ports constituting a discharge port array, an actuator for ink discharge is provided. For such  
5 actuator, there is employed, for example, one utilizing a film boiling pressure of liquid by an electrothermal converting member (heat generating element) or an electromechanical converting member (piezoelectric member) such as a piezo element.

10 In such recording apparatus constituted by an ink jet recording apparatus utilizing the recording head as explained above, a signal of a head driver 307 is transmitted to the recording head 11 through a flexible flat cable 73 thereby discharging an ink  
15 droplet according to the recording data. Also the code strip 18 provided in the chassis 10 is read by the CR (carriage) encoder 19 mounted on the carriage 13 to enable ink droplet discharge toward the recording sheet at a suitable timing. After the  
20 recording of a line in this manner, the recording sheet is conveyed by a necessary amount by the sheet conveying unit. This operation is executed repeatedly to achieve a recording operation over the entire surface of the recording sheet.

25 The recording head maintenance unit serves to prevent clogging of the discharge ports of the recording head 11 and to eliminate a smear, for

example by paper dusts, on the discharge port face of the recording head 11, thereby recovering and maintaining a normal state in the recording operation of the recording head 11. The recovery mechanism for  
5 this purpose includes, for example, a capping mechanism for covering the discharge ports, a suction recovery mechanism for sucking and discharging the ink from the discharge ports in a capped state, and a wiping mechanism for wiping and cleaning a peripheral  
10 area of the discharge ports.

More specifically, the maintenance unit 36 so provided as to oppose to the recording head 11 in a waiting position of the carriage 13 is constituted, for example, of a capping mechanism having a cap to  
15 be contacted with the discharge port face of the recording head 11 for protection thereof, a wiping mechanism having a wiper for cleaning the discharge port face, and a suction recovery mechanism having a suction pump connected with the cap for generating a  
20 negative pressure therein. In case of an ink suction for refreshing the ink in the discharge ports of the recording head 11, the cap is pressed to the discharge port face and the suction pump is activated to generate a negative pressure in the cap, thereby  
25 sucking and discharging the ink. Also in case the ink is deposited on the discharge port face after the ink suction or in case a foreign substance such as

paper dusts is deposited on the discharge port face,  
the wiper is brought into contact with the discharge  
port face and moved parallel thereto, thereby wiping  
the discharge port face and eliminating the deposited  
5 substance.

The recording apparatus has been outlined in  
the foregoing. In the following there will be given  
a detailed description on the configuration specific  
to the present embodiment, including a configuration  
10 of the auto both-side unit 2 serving as a sheet  
inversion unit or an auto inversion unit.

At first reference is made to Fig. 2 for  
explaining the path passed by the recording sheet.  
In Fig. 2, there are shown a switchable flap 104  
15 formed by a movable flap rotatably supported and  
determining a passing direction of the recording  
sheet, an exit flap 106 rotatably supported and to be  
opened and closed when the recording sheet goes out  
of the both-side unit 2, a both-side roller A 108  
20 serving as an inversion roller for conveying the  
recording sheet in the both-side unit 2, a both-side  
roller B 109 serving as an inversion roller for  
conveying the recording sheet in the both-side unit 2,  
a both-side pinch roller A 112 moving with the both-  
25 side roller A 108, and a both-side pinch roller B 113  
moving with the both-side roller B 109.

When a recording operation is initiated, the

sheet feeding roller 39 serves to feed (convey) the recording sheet one by one to the sheet conveying roller 21 from the plural recording sheets stacked on the main ASF 37. The recording sheet pinched between  
5 the sheet conveying roller 21 and the pinch roller 22 is conveyed in a direction indicated by an arrow a in Fig. 2. In case of executing a both-side recording, after the recording on the front (top) surface, the recording sheet is conveyed in a horizontal path  
10 provided below the main ASF 37 in a direction indicated by an arrow b in Fig. 2. Since the auto both-side unit 2 serving as the auto inversion unit is positioned behind the main ASF 37, the recording sheet is guided from the horizontal path into the  
15 auto both-side unit 2 and is conveyed in a direction indicated by an arrow c in Fig. 2.

In the auto both-side unit 2, the recording sheet changes the advancing direction thereof by being pinched between the both-side roller B 109 and  
20 the both-side pinch roller B 113, then is further conveyed by the both-side roller A 108 and the both-side pinch roller A 112 in a direction indicated by an arrow d in Fig. 2, and finally returns to the horizontal path with a change of the advancing  
25 direction by 180° finally. The recording sheet conveyed in the horizontal path in a direction indicated by an arrow a in Fig. 2 is again pinched by

the paper conveying roller 21 and the pinch roller 22,  
for executing recording on the rear surface. As  
explained above, the recording sheet after the  
recording on the front side is subjected to a front-  
5 back side inversion by the horizontal path below the  
main ASF 37 and the auto both-side unit 2 behind the  
main ASF 37 and is subjected to a recording on the  
back side, whereby the recordings on the front and  
back sides are automatically executed.

10 A recoding range on the front side (first side,  
top side) will be explained. The recording head 11  
is provided with a discharge port area (recording  
area, ink discharge area) N between the paper  
conveying roller 21 and the first sheet discharge  
15 roller 30, but, because of conditions of arrangement  
of the ink flow paths to the discharge ports and of  
wirings to the ink discharging actuators (discharge  
energy generating means), it is usually difficult to  
position the discharge port area N in the immediate  
20 vicinity of the nip portion of the sheet conveying  
roller 21. Therefore, within the range where the  
recording sheet is pinched between the sheet  
conveying roller 21 and the pinch roller 22, the  
recording can only be made to a position, at the  
25 downstream side of the nip portion of the sheet  
conveying roller 21, distanced by a length L1 shown  
in Fig. 2.

In order to reduce such lower end margin of the front side, the recording apparatus of the present embodiment executes the recording up to a portion where the recording sheet is released from the nip  
5 portion of the sheet conveying roller 21 and is pinched and conveyed by the first sheet discharge roller 30 and the second sheet discharge roller 31 only. In this manner the recording operation is rendered possible until the lower end margin on the  
10 front side becomes zero. However, in case of conveying the recording sheet from this state in the aforementioned direction b in Fig. 2, it is not possible (or difficult) to guide the recording sheet to the nip portion of the sheet conveying roller 21  
15 and the pinch roller 22 and there may result so-called sheet jam. In the present embodiment, in order to avoid such sheet jam, means to be explained in the following is used for releasing (separating) the pinch roller 22 from the sheet conveying roller  
20 21 thereby forming a predetermined gap, and, after an end portion of the recording sheet is drawn into such gap, the pinch roller 22 is brought into contact again with the sheet conveying roller 21, thereby enabling conveying of the recording sheet in the  
25 direction b shown in Fig. 2.

In the following, there will be explained a release mechanism for the pinch roller 22, a release

mechanism for the sheet detection lever (PE sensor lever) 66, a pressure regulating mechanism for the pinch roller spring 24, a vertical movement mechanism for the guide member (sheet guide) 70, and a vertical  
5 movement mechanism for the carriage 13.

The pinch roller 22 is released (separated or distanced) from the sheet conveying roller 21 in order to re-introduce the recording sheet as explained in the foregoing, but there are provided  
10 certain mechanisms for inverting the top and back sides of the recording sheet after the re-introduction thereof.

One of such mechanisms is a release mechanism for the PE sensor lever 66 constituting the sheet  
15 detection lever. An ordinary PE sensor lever 66 is so mounted as to be capable of rocking with a certain angle of the surface of the recording sheet, in order to exactly detect the position of the front edge or the rear edge of the recording sheet when it proceeds  
20 in the normal direction. Because of such setting, in case the sheet proceeds in the reverse direction, there is encountered technical difficulties that an end portion of the recording sheet is hooked or an end of the PE sensor lever 66 engages with the  
25 recording sheet under conveying. In the present embodiment, therefore, the PE sensor lever 66 is released from the passing sheet surface until a



middle of the front-back side inversion step of the recording sheet so as not to be in contact with the recording sheet.

The aforementioned release mechanism for the PE  
5 sensor lever 66 is not essential but may be replaced  
by another means or configuration. For example, for  
resolving the aforementioned technical difficulties,  
it is possible to provide the front end of the PE  
sensor lever 66 with a roller or the like, thereby  
10 resolving the technical difficulties by the rotation  
of such roller when the recording sheet advances in  
the opposite direction. It is also possible to adopt  
a configuration in which the PE sensor lever 66 has a  
larger rocking angle and can swing to an angle  
15 opposite to the direction opposite to the normal when  
the recording sheet is conveyed in the opposite  
direction, thereby resolving the aforementioned  
technical difficulties.

Another is a pressure regulating mechanism for  
20 the pinch roller spring 24, namely for varying a  
pressure (spring force) of the pinch roller 22 to the  
paper conveying roller 21. In the present embodiment,  
the pinch roller 22 is released by rotating the  
entire pinch roller holder 23. In a state where the  
25 pinch roller 22 is pressed to the sheet conveying  
roller 21, since the pinch roller holder 23 is  
pressed by the pinch roller spring 24, a rotation of

the pinch roller holder 23 in the releasing direction increases the pressure of the pinch roller spring 24 thereby resulting drawbacks of an increase in the load for releasing the pinch roller holder 23 or an  
5 increase in the stress applied to the pinch roller holder 23 itself. In order to prevent such phenomenon, a mechanism (pressure regulating mechanism) for reducing the pressure of the pinch roller spring 24 at the release of the pinch roller  
10 holder 23 is provided.

Another mechanism is a vertical movement mechanism for the sheet guide. The sheet guide 70 constitutes a part of a shared portion of a first sheet path for guiding the recording sheet conveyed  
15 from the auto sheet feeding unit 37 and a second sheet path for guiding the recording sheet conveyed to the auto inversion unit constituted of the both-side unit 2 or from the auto inversion unit. The sheet guide 70 is usually provided, in order to guide  
20 the recording sheet supplied from the main ASF 37 to the sheet conveying roller 21, in a position at an upward angle with respect to the horizontal path (state shown in Fig. 2), so as to smoothly guide the recording sheet to the nip portion of the LF roller  
25 21 having a certain angle from the horizontal position as explained in the foregoing. In such configuration, however, when the recording sheet is

conveyed in the direction of the arrow b in Fig. 2,  
the recording sheet is again guided to the main ASF  
37. In order to prevent such situation and to enable  
a smooth guiding to the horizontal path, it is  
5 preferable to change the angle of the sheet guide 70  
to a horizontal position. For this purpose, a  
vertical movement mechanism for vertically moving the  
sheet guide 70 constituting the guide member is  
provided.

10 A final mechanism is a vertical movement  
mechanism for the carriage 13. When the pinch roller  
holder 23 is brought into the released state, the  
front end of the pinch roller holder 23 comes close  
to the carriage 13, and this mechanism is provided in  
15 order to prevent the mutual contact of the two,  
thereby avoiding a situation where the carriage 13  
cannot be moved in the main scanning direction.  
Therefore a vertical movement mechanism is provided  
for elevating the carriage 13 in synchronization with  
20 the releasing operation of the pinch roller holder 23.  
This vertical movement mechanism for the carriage 13  
can also be utilized for other purposes, for example  
in case of retracting the recording head 11 in order  
to prevent contact of the recording head 11 and the  
25 recording sheet in case of recording a thick  
recording sheet.

In the following detailed explanations will be

given on the foregoing five mechanisms.

Fig. 3 is a schematic perspective view showing the configuration of the pinch roller release mechanism, the PE sensor lever release mechanism, the  
5 pinch roller spring pressure regulating mechanism and the sheet guide vertical movement mechanism.

In Fig. 3, there are shown a pinch roller holder pressing cam 59 in contact with the pinch roller holder 23, a pinch roller spring pressing cam  
10 60 constituting a function point of the pinch roller spring 24, a PE sensor lever pressing cam 61 in contact with the PE sensor lever 66, a lift cam shaft shield plate 62 including an angle of the lift cam shaft 58, a sheet guide pressuring cam 65 in contact  
15 with the sheet guide 70, a PE sensor lever 66 in contact with the recording sheet for detecting a front edge or a rear edge thereof, a PE sensor 67 to be exposed (or permeated)/masked (or blocked) by the PE sensor lever 66, a PE sensor lever spring 68 for  
20 biasing the PE sensor lever 66 in a predetermined direction, a lift cam sensor 69 to be exposed/masked by the lift cam shaft shield plate 62, and a sheet guide spring 71 for biasing the sheet guide 70 in a predetermined direction.

25 The pinch roller release mechanism, the PE sensor lever release mechanism, the pinch roller spring pressure regulating mechanism and the sheet

guide vertical movement mechanism are operated by a rotation of the lift cam shaft 58. In the configuration of the present embodiment, the pinch roller holder pressing cam 59, the pinch roller spring pressing cam 60, the PE sensor lever pressing cam 61 and the sheet guide pressing cam 65 are respectively fixed on the lift cam shaft 58, whereby the respective cams function in synchronization with a turn of the lift cam shaft 58. An initial angle and a turn of the lift cam shaft 58 are recognized by the lift cam shaft shield plate 62 which exposes or masks the lift cam sensor 69. The concept of the present invention is not limited by such configuration, and there may also be employed a mechanism which drives these mechanisms independently.

In the following, function of each mechanism will be explained.

Figs. 4A to 4C are partial lateral views schematically showing functions of the pinch roller release mechanism and the pinch roller spring pressure regulating mechanism. Fig. 4A shows a state where the pinch roller holder pressing cam 59 is in an initial state, the pinch roller 22 is pressed to the sheet conveying roller 21 and the pinch roller spring 24 has a pressure of a standard state. The pinch roller holder 23 is rotatably supported, at a pinch roller holder shaft 23a, by bearings in the

chassis 10, and is capable of a rocking motion over a predetermined angular range. The pinch roller holder 23 rotatably supports, at an end thereof, the pinch roller 22 and is provided, at the other end, with an area for impinging on the pinch roller holder pressing cam 59.

As shown in Fig. 4A, the pinch roller spring 24 is formed by a torsion coil spring, which impinges at an end, as a function point, on the pinch roller holder 23 at a side thereof at the pinch roller 22, is supported at the other end by the pinch roller spring pressing cam 60 and is supported at an intermediate portion of the spring by a support portion of the chassis 10. Owing to such support, the pinch roller 22 is pressed under a predetermined pressure to the sheet conveying roller 21. By activating the rotating mechanism for the sheet conveying roller 21 in this state, it is possible to convey the recording sheet pinched in the nip portion of the sheet conveying roller 21 and the pinch roller 22.

Fig. 4B shows a state where the pinch roller 22 is in a released (separated) state, and the pinch roller spring 24 is in a load-removed state. More specifically, by a rotation of the lift cam shaft 58 in a direction indicated by an arrow a in Figs. 4A to 4C, the pinch roller holder pressing cam 59 impinges

on the pinch roller holder 23 to gradually rotate the pinch roller holder 23 in a direction of an arrow b in Figs. 4A to 4C, whereby the pinch roller 22 is released (separated or distanced) from the sheet  
5 conveying roller 21. Also in the state shown in Fig. 4B, the pinch roller spring pressing cam 60 contacts the pinch roller spring 24 at a smaller radius and a torsion angle  $\theta_2$  of the pinch roller spring 24 is larger than the angle  $\theta_1$  in the state shown in Fig.  
10 4A, whereby the load of the spring is reduced and the pinch roller holder 23 is almost free from the load. Therefore, the pinch roller holder 23 is in a state almost free from the stress. In this state, a gap H of a predetermined amount is formed between the sheet  
15 conveying roller 21 and the pinch roller 22, and the front edge of the recording sheet, even in case of being roughly guided, can be easily inserted into the nip portion.

Fig. 4C shows a state where the pinch roller 22  
20 is pressed to the sheet conveying roller 21 as in Fig. 4A, but in a light contact state with a weaker contact pressure. In the state shown in Fig. 4C, a further rotation of the lift cam shaft 58 in the direction of the arrow a in Figs. 4A to 4C releases  
25 the contact between the pinch roller holder pressing cam 59 and the pinch roller holder 23, the pinch roller holder 23 rotates in a direction of an arrow c

in Figs. 4 to return to the original state, and the pinch roller spring pressing cam 60 contacts the pinch roller spring 24 with such a radius between those in Figs. 4A and 4B.

5           Thus, the torsion angle  $\theta_3$  of the pinch roller spring 24 is somewhat smaller than the angle  $\theta_1$  in Fig. 4A, so that the contact force of the pinch roller 22 to the sheet conveying roller 21 becomes somewhat smaller. In such configuration, in case a  
10 recording sheet thicker than normal is pinched between the sheet conveying roller 21 and the pinch roller 22, there can be prevented a situation where the torsion angle of the pinch roller spring 24 becomes larger than in the ordinary situation thereby  
15 increasing the load generated to the pinch roller holder 23. It is therefore possible to equalize the rotational load by the axial loss of the sheet conveying roller 21 for a recording sheet of an ordinary thickness and for a thicker recording sheet.

20           When the lift cam shaft 58 is rotated by one turn through the aforementioned states, the pinch roller release mechanism and the pinch roller spring pressure regulating mechanism return to a standard state shown in Fig. 4A.

25           Figs. 5A and 5B are partial lateral views schematically showing the functions of the PE sensor lever vertical movement mechanism. Fig. 5A



illustrates a state where the PE sensor lever pressing cam 61 is in an initial state and the PE sensor lever 66 is in a free state. the PE sensor lever 66 is rotatably supported, by a PE sensor lever shaft 66a, by bearings in the chassis 10. In the state shown in Fig. 5A, the PE sensor lever 66 is biased to the illustrated position by the PE sensor lever spring 68, and the PE sensor 67 is masked by a shield plate of the PE sensor lever 66. When a recording sheet passes this position in this state, the PE sensor lever 66 rotates clockwise in Fig. 5A, whereby the PE sensor 67 is exposed thereby being capable of detecting the presence of the recording sheet. Such masked and exposed states allow to detect the front edge and the rear edge of the recording sheet.

Fig. 5B is a partial lateral view schematically showing a state where the PE sensor lever 66 is locked. In Fig. 5B, a rotation of the PE sensor lever pressing cam 61 in the direction of the arrow a causes a cam follower portion of the PE sensor lever 66 to be pushed up and rotated in a direction indicated by an arrow b. In this state, a sheet detecting portion of the PE sensor lever 66 is hidden inside the pinch roller holder 23, so that the PE sensor lever 66 does not contact the recording sheet even it is present in the path. Therefore, in case

the recording sheet is conveyed in the direction of the arrow 2 in Fig. 2 in this state, the recording sheet can be prevented from jamming by contacting the PE sensor lever 66.

5           Figs. 6A and 6B are partial lateral views schematically showing functions of the sheet guide vertical movement mechanism. Fig. 6A shows a state where the sheet guide 70 is in an up-state. Referring to Fig. 6A, the sheet guide 70 is usually  
10           biased in a lifted direction by the sheet guide spring 71, and is defined in position by impinging on an unillustrated stopper. By the function of the sheet guide spring 71 serving as an elastic member, the sheet guide 70 maintains this position (up-state)  
15           when a recording sheet supplied from the main ASF passes. However, the sheet guide 70 can be lowered against the spring force of the sheet guide spring 71 in case a force larger than in the normal state is applied.

20           Fig. 6B shows a state where the sheet guide 70 is in a down-state. Referring to Fig. 6B, a rotation of the sheet guide pressing cam 65 fixed to the lift cam shaft 58 in a direction of an arrow a in Figs. 6A and 6B causes the sheet guide pressing cam 65 to  
25           impinge on and gradually press a sheet guide cam follower 70a which constitutes a part of the sheet guide 70. Thus the sheet guide 70 is rotated in a

direction of an arrow b in Figs. 6A and 6B and is pressed down against the spring force of the sheet guide spring 71. In this state, a portion of the sheet guide 70 facing the sheet path becomes

5 substantially horizontal whereby the sheet path becomes almost completely straight. Thus, when the sheet is conveyed in the direction of the arrow b in Fig. 2 by the sheet conveying roller 21, the recording sheet is conveyed horizontally and an

10 already recorded portion on the surface of the recording sheet is prevented from being pressed to an upper portion of the sheet path.

Fig. 7 is a schematic perspective view showing a carriage vertical movement mechanism. In Fig. 7,

15 there are shown a right guide shaft cam 14a mounted on the guide shaft 14, a left guide shaft cam 14b mounted on the guide shaft 14, and a cam idler gear 53 connecting a lift cam gear 52 and a gear integral with the right guide shaft cam 14a. The guide shaft

20 14 is supported by both lateral faces of the chassis 10 as shown in Fig. 1, and is fitted in an unillustrated vertically elongated holes thereby being freely movable in a direction indicated by an arrow Z in Fig. 7 but being prevented from movement

25 in directions of arrows X and Y in Fig. 7.

In the mechanism shown in Fig. 7, the guide shaft 14 is normally biased downwards (opposite to

the arrow Z) by the guide shaft spring 74, but, when the cam idler gear 53 rotates, the right guide shaft cam 14a and the left guide shaft cam 14b impinge on the guide slopes 56 whereby the guide shaft 14  
5 rotates and moves vertically.

Figs. 8A to 8C are partial lateral views schematically showing functions of the carriage vertical movement mechanism. Fig. 8A shows a state where the carriage 13 is in a first carriage position  
10 which is a standard position. In this state, the guide shaft 13 is defined in position by impinging on a lower end of the elongated guide hole 57 of the chassis 10, and the guide shaft cam 14a is not in contact with the guide slope 56.

15 Fig. 8B shows a state where the carriage 13 is moved to a somewhat higher second carriage position. A rotation of the lift cam shaft 58 causes the lift cam gear 52, fixed on the lift cam shaft 58, to rotate, whereby the guide shaft cam 14c rotates  
20 through the cam idler gear 53 meshing with the lift cam gear 52. A rotation of the guide shaft cam 14c causes the carriage 13, guided and supported by the guide shaft 14, to be displaced (elevated) from the first carriage position to the second carriage  
25 position. By selecting a same number of teeth for the lift cam gear 52 and the guide shaft cam gear 14c, the lift cam shaft 58 and the guide shaft 14 rotate

in a same direction by approximately same angles.  
The rotations are not in a completely same angle,  
because the lift cam gear 52 and the cam idler gear  
53 have fixed rotary axes while the guide shaft 14  
5 itself, constituting a rotary axis of the guide shaft  
cam gear 14c, can move vertically whereby the  
distance between the gears changes.

Such rotation of the lift cam shaft 58 in the  
direction of the arrow a in Figs. 8A, 8B and 8C  
10 causes the guide shaft 14 to also rotate in a  
direction of an arrow b in Figs. 8A, 8B and 8C. This  
rotation causes the guide shaft cams 14a and 14b to  
respectively impinge on the guide slope 56 in a fixed  
position. In this state, since the moving direction  
15 of the guide shaft 14 is limited to the vertical  
direction by the elongated guide hole 57 of the  
chassis 10 as explained before, the guide shaft 14  
moves to the second carriage position. Such shift to  
the second carriage position is also suitable in case  
20 the recording sheet shows a large deformation to  
cause a contact of the recording sheet and the  
recording head 11 in the first carriage position.

Fig. 8C shows a state where the carriage 13 is  
in a highest third carriage position. A further  
25 rotation of the lift cam shaft 58 from the second  
carriage position causes the guide shaft cams 14a,  
14b to contact the guide slope 56 with portions of

larger radii, whereby the guide shaft 14 is moved to a still higher position. Such third carriage position is suitable also for a recording medium (recording sheet) thicker than normal.

5           In the foregoing, detailed explanations on the five mechanisms, namely the pinch roller release mechanism, the PE sensor lever release mechanism, the pinch roller spring pressure regulating mechanism and the sheet guide vertical movement mechanism, have  
10   been given.

Fig. 9 is a schematic perspective view showing a drive mechanism for the lift cam shaft. In the following, the drive mechanism for the lift cam shaft 58 will be explained. In the present embodiment, the  
15   ASF motor 46 for driving the main ASF 37 is employed as a drive source for the lift cam shaft 58, and is controlled in the rotating direction and the rotating amount to suitably operate the main ASF 37 or the lift cam shaft 58.

20           In Fig. 9, there are shown an ASF motor 46 constituting a drive source (upper half being removed in illustration in order to show gears), an ASF pendulum arm 47 positioned next to a gear mounted on the ASF motor 46, an ASF solar gear 48 mounted at a  
25   center of the ASF pendulum arm 47, an ASF planet gear 49 mounted at an end of the ASF pendulum arm 47 and meshing with the ASF solar gear 48, a pendulum

locking cam 63 fixed to the lift cam shaft 58, and a pendulum locking lever 64 capable of rocking to act on the pendulum locking cam 63.

As explained in the foregoing, the transmitting  
5 direction of the driving force of the ASF motor 46 is determined by the rotating direction thereof, and the ASF motor 46 is rotated in a direction indicated by an arrow a in Fig. 9 for driving the lift cam shaft 58, whereby a gear mounted on the ASF motor 46  
10 rotates the ASF solar gear 48. As the ASF solar gear 48 and the ASF pendulum arm 47 engage mutually rotatably with a predetermined frictional force, the ASF pendulum arm 47 rocks in the rotating direction (indicated by an arrow b in Fig. 9) of the ASF solar  
15 gear 48. Thus the ASF planet gear 49 meshes with a next lift input gear 50. In this manner the driving force of the ASF motor 46 is transmitted to the lift cam gear 52 through the lift reducing gear train 51. In this state, the ASF pendulum arm 47 rocks to the  
20 direction of the arrow b in Fig. 9, whereby the driving power to the gear train for driving the main ASF 37 is cut off.

On the other hand, in case of driving the main ASF 37, the ASF motor 46 is rotated opposite to the  
25 direction of the arrow a in Fig. 9, so that the ASF pendulum arm 47 rocks in a direction opposite to the arrow b in Fig. 9. Thus the ASF planet gear 49 is

released from the lift input gear 50, and another ASF planet gear 49 provided on the ASF pendulum arm 47 meshes with the gear train of the main ASF 37, thereby driving the main ASF 37.

5           In the present embodiment, the ASF motor 46 is constituted of so-called stepping motor with an open loop control, but it is naturally possible to employ a closed loop control utilizing an encoder on a DC motor or the like.

10           In case a planet gear mechanism is employed for the driving power transmission and a negative load is generated at the driven side, there may result so-called an overtaken state in which the gears are disengaged by a movement of the pendulum lock lever  
15 64 and the driven side advances in phase than the driving side. In order to prevent such phenomenon, the present embodiment is provided with the pendulum locking cam 63 and the pendulum locking lever 64. In case the lift cam shaft 58 is within a predetermined  
20 angular range, based on a cam face shape of the pendulum locking cam 63, the pendulum locking lever 64 rocks in a direction of an arrow c in Fig. 9 whereby the pendulum locking lever 64 engages with and fixes the ASF pendulum arm 47 so as not to return  
25 to the side for driving the main ASF 37. Therefore the ASF planet gear 49 is constantly maintained in a meshing state with the lift input gear 50, and the



ASF motor 46 and the lift cam shaft 58 rotate always in synchronization.

In case the pendulum locking cam 63 returns to a predetermined angular range, the pendulum locking lever 64 returns in a direction opposite to the arrow c in Fig. 9, whereby the ASF pendulum arm 47 is unlocked and returns to a state where the driving power transmitted to the main ASF 37 by a reverse rotation of the ASF motor 46.

10       The aforementioned mechanisms of the lift cam shaft 58 enable a release of the pinch roller 22, a locking of the PE sensor lever 66, a pressure regulation of the pinch roller spring 24, a vertical movement of the sheet guide 70 and a vertical  
15 movement of the carriage 13. In the following, these five mechanisms will be collectively called lift mechanisms.

In the following, there will be explained how these five lift mechanisms function in mutual  
20 correlation. Figs. 10A, 10B, 10C and 10D are schematic lateral views showing functions of the carriage 13, the pinch roller 22, the PE sensor lever 66 and the sheet guide 70.

Fig. 10A shows a state where the lift  
25 mechanisms are in a first position. In this state, the pinch roller 22 is pressed (press-contacted) to the sheet conveying roller 21, the PE sensor lever 66

is in a free state, the pinch roller spring 24 (Figs. 4A to 4C) is pressed with an ordinary pressure, the sheet guide 70 is in an up-state, and the carriage 13 is in the first carriage position.

5           This state shown in Fig. 10A is used for a recording operation utilizing an ordinary recording sheet, or for a registration after the inversion of the recording sheet in the auto both-side unit 2. The carriage 13 is supported movably along the guide  
10 shaft 14, and can be vertically moved by vertically moving the guide shaft 14 along an elongated guide hole 57 formed in the chassis 10.

          Fig. 10B shows a state where the lift mechanisms are in a second position. In this state,  
15 the pinch roller 22 is pressed to the sheet conveying roller 21, the PE sensor lever 66 is in a free state, the pinch roller spring 24 is pressed under an ordinary pressure, the sheet guide 70 is in an up-state, and the carriage 13 is in the second carriage  
20 position. In comparison with the first position of the lift mechanisms, this state is different only in the position of the carriage 13. This state is used for preventing a frictional contact of the recording sheet and the recording head 11 in case the  
25 recording sheet shows a large deformation, or for a recording sheet of a certain larger thickness.

          Fig. 10C shows a state where the lift

mechanisms are in a third position. In this state, the pinch roller 22 is released with a predetermined gap from the sheet conveying roller 21, the PE sensor lever 66 is retracted upward and locked, the pinch roller spring 24 has a weaker pressure, the sheet guide 70 is in a down-state, and the carriage 13 is in the highest third carriage position. In comparison with the second position of the lift mechanisms, states are changed in all the mechanisms to open the sheet path in a straight state and to enable introduction of the recording sheet. This state is used for conveying the recording sheet in a direction of an arrow b in Fig. 2 after the recording on the front side of the recording sheet, or for inserting a recording sheet of a large thickness.

Fig. 10D shows a state where the lift mechanisms are in a fourth position. In this state, the pinch roller 22 is pressed to the sheet conveying roller 21, the PE sensor lever 66 is retracted upward and locked, the pinch roller spring 24 is pressed with a somewhat weaker pressure, the sheet guide 70 is in a down-state, and the carriage 13 is in the highest third carriage position. In comparison with the third position of the lift mechanisms, the pinch roller 22 returns to the pressed state, and the pinch roller spring 24 is so changed as to be pressed with a somewhat weaker pressure. This state is used in

case of conveying, in an auto both-side recording,  
the recording sheet toward the auto both-side unit 2  
after the re-introduction of the recording sheet, or  
for a recording with a recording sheet of a large  
5 thickness.

In the present embodiment, in consideration of  
the functions of the recording apparatus, the lift  
mechanisms are limited to the aforementioned four  
positions as shown in Figs. 10A to 10D in order to  
10 simplify the configuration. More specifically, the  
positions change cyclically in the order of first  
position - second position - third position - fourth  
position during a turn of the lift cam shaft 58.  
However, the present invention is not limited to such  
15 embodiment, and there may be employed a configuration  
in which the components of the mechanisms are  
operated independently. Also the pressure regulating  
mechanism for the pinch roller spring 24 is not  
essential, but can be dispensed with in case the  
20 pinch roller holder 23 has a sufficiently high  
rigidity or the load fluctuation of the LF motor 26  
is negligible. Also the vertical movement mechanism  
for the sheet guide 70 may be dispensed with, in case,  
for example by a positioning of the main ASF 37, the  
25 front edge of the recording sheet can be  
satisfactorily guided to the nip portion of the sheet  
conveying roller 21 even with a horizontal sheet

guide 70.

Fig. 11 is a timing chart showing the function states of the lift mechanisms. In order to clarify further the contents explained in the foregoing  
5 schematic lateral views in Fig. 4A to 10D, an explanation will be given again with reference to a timing chart in Fig. 11. The abscissa indicates an angle of the lift cam shaft 58 over a range of  $360^\circ$  and the ordinate indicates each mechanism and a  
10 position thereof. As shown in Fig. 11, a synchronized operation of the lift cam shaft 58 and the guide shaft 14 allows to simultaneously operate the plural mechanisms, by detecting the angle of the lift cam shaft 58 with the lift cam sensor 69 (Fig.  
15 3), and controlling the rotation angle of the ASF motor 46 (Fig. 21).

The functions of the lift mechanisms have been explained in the foregoing.

Figs. 12A, 12B and 12C are schematic lateral  
20 views showing steps of re-entry of a recording sheet 4, after a recording on a front side thereof, into the nip portion of the sheet conveying roller 21. In the following, a specific explanation will be given on how an auto both-side recording is achieved on a  
25 recording sheet.

Fig. 12A shows a state where the recording sheet 4 has completed the recording on the front side

and is supported by the first sheet discharge roller 30 and the first spur train 32, and the second sheet discharge roller 31 and the second spur train 33. In this state, the lift mechanisms are in the first or  
5 second position. As explained in the foregoing, by executing the recording under advancement of the recording sheet 4 to such position, the rear end of the recording sheet 4 can be brought to a position opposed to the discharge port array (discharge nozzle  
10 array) of the recording head 11, whereby it is rendered possible to execute the recording down to the rear end of the recording sheet 4 without forming a rear margin thereon.

Then the lift mechanisms are shifted to the  
15 third position as shown in Fig. 12B, thereby forming a predetermined large gap between the pinch roller 22 and the sheet conveying roller 21. It is thus rendered possible to easily introduce the rear end of the recording sheet 4, even with a certain undulation  
20 or an upward curling. In this state, the pinch roller holder 23 and the carriage 13 do not mutually interfere, so that the carriage 13 may be present in any position in the main scanning direction.

Fig. 12B shows a state where the recording  
25 sheet 4 is conveyed in a direction of the arrow b in Fig. 2 (hereinafter the conveying of the recording sheet 4 in such direction being called a back-feed)

by rotating the first sheet discharge roller 30 in a direction indicated by an arrow from a state shown in Fig. 12B and is stopped under the pinch roller 22. A stopping in this state is adopted because the  
5 recording apparatus of the present embodiment employs an ink jet recording method of wet type. The recorded side of the recording sheet 4 (upper surface in Figs. 12A, 12B and 12C) is in a wet state immediately after the recording operation and, if  
10 immediately pinched between the pinch roller 22 and the sheet conveying roller 21, the ink is transferred onto the pinch roller 22 and is transferred again onto the recording sheet 4 in a subsequent conveying process thereby causing a smear thereon.

15       Whether the ink transfers onto the pinch roller 22, stated differently whether the ink is dry or not, is influenced by various factors. Such factors include a type of the recording sheet, a type of the used ink, a superposed deposition method of the used  
20 ink, a deposition amount of the used ink per unit area (for example density per unit area of recorded data), an environmental temperature of the recording operation, an environmental humidity of the recording operation, an environmental gas flow rate of the  
25 recording operation etc. In brief, the ink tends to dry faster on a recording sheet having an ink receiving layer at the surface and capable of

introducing the ink promptly into the interior. Also a faster drying is possible with an ink employing smaller ink particles such as a dye and easily permeable into the interior of the recording sheet.

- 5 Also a faster drying is possible with an ink system utilizing chemically reactive inks which are solidified by superposed deposition onto the surface of the recording sheet.

- Also a faster drying is possible by reducing  
10 the ink amount deposited per unit area. Also a faster drying is possible by elevating the environmental temperature of the recording operation. Also a faster drying is possible by lowering the environmental humidity of the recording operation.  
15 Also a faster drying is possible by elevating the environmental gas flow rate of the recording operation. Since the necessary drying time varies by various conditions as explained above, the present embodiment adopts a configuration of employing, as a  
20 standard value, a drying time required in a recording operation with a predetermined ink system under ordinary conditions of use (ordinary recording sheet and ordinary recording environment), and regulating such standard value with a predictable condition to  
25 obtain a drying time.

The predictable condition is an ink amount deposited per unit area, but it is possible also to



achieve a finer prediction of the waiting time for drying, by employing means for detecting the environmental temperature, means for detecting the environmental humidity, means for detecting the environmental air flow rate etc. in combination. The waiting time for drying can be determined, for example, by storing the data received from the host apparatus 308 (Fig. 21) in the RAM 312 (Fig. 21), calculating the ink amount to be deposited per unit area and comparing a maximum value with a predetermined threshold value stored in the ROM 311 (Fig. 21). The waiting time for drying can be optimized according to the pattern to be recorded, by increasing the waiting time for a larger maximum value of the ink amount per unit area and decreasing the waiting time for a smaller maximum value.

The waiting time for drying is also variable depending on whether the ink used for recording is a dye-based ink or a pigment-based ink, and may be made shorter for a dye-based ink which dries faster and longer for a pigment-based ink which dries slower. Also the waiting time for drying may be made shorter at a higher ambient temperature causing a faster drying, or longer at a lower ambient temperature causing a slower drying. Also the waiting time for drying may be made longer at a higher ambient humidity causing a slower drying, or shorter at a

lower ambient humidity causing a faster drying. Also the waiting time for drying may be made shorter in case of a recording sheet having an ink receiving layer on the surface and capable of immediately  
5 introducing the deposited ink into the interior because the surface of the recording sheet can be easily dried, and made longer for a strongly water-repellent recording sheet which is more difficult to dry.

10       Such waiting for drying may be made in the state shown in Fig. 12A, but is preferably executed after a back-feed of the recording sheet 4 to a position shown in Fig. 12B. This is because of a deformation in the recording sheet 4. In case of a  
15 recording on the recording sheet 4 with a wet ink jet process, a water absorption of the recording sheet 4 causes a dilatation of fibers constituting the recording sheet 4, thereby resulting in an elongation thereof. Depending on the recorded pattern, the  
20 recording sheet 4 may generate a relatively significantly elongated portion and a relatively insignificantly elongated portion, and, in such case, the surface of the recording sheet 4 shows a conspicuous undulation with a lapse of time after the  
25 recording. Magnitude of such undulation depends principally on the time after the start of water absorption by the recording sheet 4, and increases

with the lapse of time, converging to a predetermined deformation amount.

Therefore, in case the deformation at the end of the recording sheet 4 becomes large after a  
5 prolonged lapse of time, even if the pinch roller 22 is released from the sheet conveying roller 21, there is a possibility that the end portion of the recording sheet 4 interferes with the pinch roller 22 thereby causing a jam. In order to avoid such  
10 situation, the recording sheet 4 after the recording is subjected to the back-feeding and is moved to the position under the pinch roller 22 before the undulation by the deformation of the recording sheet 4 becomes large. Because of the aforementioned  
15 reason, the present embodiment adopts a configuration of awaiting the drying of the recorded portion of the recording sheet 4 after back-feeding of the rear end of the recording sheet 4 to the position shown in Fig. 12B. The gap between the sheet conveying roller 21  
20 and the pinch roller 22 when separated is selected larger than an amount of deformation of the recording sheet after the recording of a first side (front side) thereof.

Fig. 12C shows a state in which the recording  
25 sheet is conveyed to the auto both-side unit 2. When the recorded portion of the recording sheet 4 is dried and reaches a state where the ink is no longer

transferred to the pinch roller 22 in a contact state,  
the lift mechanisms are shifted to the fourth  
position as shown in Fig. 10D to pinch the recording  
sheet 4 by the pinch roller 22 and the sheet  
5 conveying roller 21. In this state the sheet  
conveying roller 21 is driven to back-feed the  
recording sheet 4. In this state, since the PE  
sensor lever 66 is rotated upward and locked, there  
can be prevented a situation where the end portion  
10 thereof is trapped in the recording sheet 4 or rubs  
the recorded portion to cause a peeling.

Also the sheet guide 70 is in the down-state  
and forms a substantially horizontal sheet path, so  
that the recording sheet 4 can be straightly conveyed  
15 toward the auto both-side unit 2. In the present  
embodiment, the sheet guide 70 is basically  
maintained in the up-state, but the present invention  
is not restricted by such embodiment and the sheet  
guide 70 may be normally maintained in the down-state.  
20 More specifically, the lift mechanisms may normally  
wait in the third or fourth position and may be  
shifted to the first position at the sheet feeding  
operation from the main ASF 37. Such configuration  
enables a smooth insertion at the insertion of a  
25 recording sheet of a high rigidity from the side of  
the sheet discharge rollers.

The conveying of the recording sheet 4 after

the end of the recording on the front side to the auto both-side unit 2 is conducted as explained above.

Fig. 13 is a schematic lateral cross-sectional view showing arrangement of a sheet path and  
5 conveying rollers in the auto both-side unit 2. In the following a conveying of the recording sheet 4 in the auto both-side unit 2 will be explained with reference to Fig. 13.

Referring to Fig. 13, there are shown a both-  
10 side unit frame 101 constituting a structural member of the auto both-side unit 2 and constituting a part of a sheet conveying path, an inner guide 102 fixed in the interior of the both-side unit frame 101 and constituting a part of the sheet conveying path, a  
15 rear cover 103 provided open-closably in a rear part of the both-side unit frame 101 and constituting a part of the sheet conveying path, a switching flap spring 105 for biasing a switching flap 104 in a predetermined direction, an exit flap spring 107 for  
20 biasing an exit flat 106 in a predetermined direction, a both-side roller rubber A 110 constituting a rubber portion of a both-side roller A 108, and a both-side roller rubber B 111 constituting a rubber portion of a both-side roller B 109.

25 When the recording sheet 4 is conveyed in a state shown in Fig. 12C to the auto both-side unit 2, the exit flap 106 is biased, by the function of the

exit flap spring 107, in a position closing an upper conveying path and opening a lower conveying path as shown in Fig. 13, so that an entrance path is determined uniquely. Therefore the recording sheet 4 proceeds to the lower conveying path as indicated by an arrow a in Fig. 13. Then the recording sheet 4 impinges on the switching flap 104, and, since the switching flap spring 105 is so selected that the switching flap 104 does not rotate for an ordinary recording sheet 4 suitable for both-side recording, the recording sheet 4 proceeds along a sheet path between the switching flap 104 and the both-side unit frame 101. The recording sheet 4, proceeding in this state, is contacted at the recorded (front) side thereof with the both-side roller rubber B 111 of the both-side roller B 109 and at the unrecorded (back) side thereof with the both-side pinch roller B 113 formed by a polymer material of a high lubricating property, and is supported therebetween.

Since the both-side roller A 108, the both-side roller B 109 and the sheet conveying roller 21 are rotated at substantially same peripheral speeds by a drive mechanism to be explained later, the recording sheet 4 is conveyed without a slippage to the both-side roller B 109. Also such substantially same peripheral speeds prevent the recording sheet 4 from becoming slack or subjected to a tension. After a

change in the advancing direction along the both-side roller B 109, the recording sheet 4 proceeds along the rear cover 103 and is similarly supported between the both-side roller rubber A 110 of the both-side roller A 108 and the both-side pinch roller A 112.

After a change in the advancing direction again along the both-side roller A 108, the recording sheet 4 is conveyed in a direction of an arrow b in Fig. 13. These both-side roller A 108 and both-side roller B 109 constitute inversion rollers for inverting the front and back sides or the conveyed direction of the recording sheet 4. In the course of advancement of the recording sheet 4 in this state, the front edge thereof impinges on the exit flap 106. The exit flap 106 is biased by the exit flap spring 107 of a very low power so that the recording sheet 4 itself pushes away the exit flap 106 and exits from the auto both-side unit 2. Also the sheet path length in the auto both-side unit 2 is selected that the rear end of the recording sheet 4 in the advancing direction thereof has already passed under the exit flap 106 when the front edge of the recording sheet 4 in the advancing direction thereof exits from the exit trap 106, so that there is no mutual friction between the front edge portion and the rear edge portion of the recording sheet 4.

Detailed operations will be explained later

with reference to a flow chart, but the length of the recording sheet can be measured by the PE sensor lever 66 at the recording on the front side of the recording sheet 4. Therefore, in case a recording  
5 sheet shorter than the distance from the sheet conveying roller 21 to the both-side roller B 109 or shorter than the distance from the both-side roller A 108 to the sheet conveying roller 21, or a recording sheet longer than a turn-around distance of the auto  
10 both-side unit 2 from the exit flap 106 to the exit flap 106 is inserted, an alarm is given at the completion of the recording on the front side and the recording sheet 4 is discharged without conveying to the auto both-side unit 2.

15 Now there will be explained reason why the recorded surface of the recording sheet 4 is conveyed at the side of the both-side roller rubber A 110 and the both-side roller rubber B 111. The both-side roller rubber A 110 and the both-side roller rubber B  
20 111 are in the driving side, while the both-side pinch roller A 112 and the both-side pinch roller B 113 are in the driven side. Therefore, the recording sheet 4 is conveyed by the rollers of the driving side, and the rollers of the driven side are rotated  
25 by the friction with the recording sheet 4. Such driving method is acceptable when the rotary axes supporting the both-side pinch roller A 112 and the



both-side pinch roller B 113 have a sufficiently small axial loss, but in case the axial loss increases for some reason, there may result a slippage between the recording sheet 4 and the both-side pinch roller A 112 or the both-side pinch roller B 113. The recorded portion of the recording sheet 4 has been dried to such an extent that the ink is not transferred by a contact with the roller, but there may result an ink peeling from the surface of the recording sheet 4 in case it is rubbed.

In case the recorded surface of the recording sheet 4 is maintained in contact with the both-side pinch roller A 112 and the both-side pinch roller B 113 and causes a slippage to such rollers, the ink on the recorded surface may be peeled off. In order to avoid such situation, the present embodiment employs such an arrangement that the rollers of the driving side are contacted with the recorded (front) side and the rollers of the driven side are contacted with the unrecorded (back) side.

Another reason, to be explained in the following, can also be mentioned for adopting such arrangement.

The both-side roller A 108 or the both-side roller B 109 of the driving side is preferably given a certain large diameter because of a restriction that a radius of curvature of the recording sheet 4

should not preferably be made excessively small,  
while the both-side pinch roller A 112 or the both-  
side pinch roller B 113 can be realized with a small  
diameter. Therefore, for designing a compact auto  
5 both-side unit 2, the both-side pinch roller A 112  
and the both-side pinch roller B 113 are often  
designed with a small diameter.

Also the recorded surface of the recording  
sheet 4 does not basically cause a transfer of the  
10 ink to the contacting roller, but may still cause a  
transfer in a very small amount, thereby gradually  
smearing the roller which is contact with the  
recorded surface. A roller of a smaller diameter,  
having a higher frequency of contact of a unit  
15 peripheral area of the roller with the recording  
sheet 4, is smeared faster than a roller of a larger  
diameter and can therefore be considered  
disadvantageous with respect to such smearing. In  
consideration of such compactization of the apparatus  
20 and such roller smearing, the present embodiment  
adopts an arrangement in which the recorded (front)  
side of the recording sheet is contacted by the both-  
side roller A 108 and the both-side roller B 109 of  
larger diameters.

25 Another reason, to be explained in the  
following, can also be mentioned for adopting such  
arrangement.

In case of pinching and conveying a recording sheet by a pair of rollers one of which is driven, it is customary to employ an elastic material in either of the rollers in order to secure a certain area of nip (nip area), and, in order to obtain an accurate conveying amount, to employ a material of a high friction coefficient at the driving side and a material of a low friction coefficient at the driven side. A rubber material (rubber-like elastomer) providing a high friction coefficient and a high elasticity with a low cost is usually employed for the material constituting the roller of the driving side. Also for increasing the conveying power, there is often employed a structure of applying a surface polishing on the rubber, including an elastomer or the like, and intentionally leaving polishing grains constituting minute irregularities. In such case, the driven side is usually formed with a polymer resin with a relatively low friction coefficient.

In a comparison of a rubber surface with small surface irregularities, and a surface formed by a smooth polymer resin, the ink stain sticks to either when it is contacted with the recorded surface of the recording sheet, but the rubber with minute surface irregularities can retain the stain on the surface by such irregularities and transfers little the stain again onto the recording sheet, while the smooth

polymer resin tends to show peeling of the stain and cause a re-transfer onto the recording sheet. It is therefore considered advantageous to contact rubber with the recorded surface of the recording sheet.

5 Also because of this reason, the present embodiment adopts an arrangement in which the rollers of a rubber material are provided at a side contacting the recorded side of the recording sheet and the rollers of a polymer resin material are provided at a side  
10 contacting the non-recorded side of the recording sheet.

The reversing operation for executing a both-side recording on an ordinary recording sheet has been explained in the foregoing.

15 In the following there will be explained functions of the auto both-side unit 2 in case of a recording on a highly rigid recording medium, without both-side recording. A recording medium of a high rigidity can be, for example, a cardboard of a  
20 thickness of 2 to 3 mm, or a disk-shaped or irregular-shaped recording medium placed on a predetermined tray. Such recording medium, because of its high rigidity, cannot be so bent as to match the diameter of the both-side rollers in the auto  
25 both-side unit 2 and cannot, therefore, be subjected to an auto both-side recording. However, there can be conceived a situation where a recording on such

recording medium is desired while the auto both-side unit 2 is attached to the recording apparatus. In case the recording medium has a high rigidity, a feeding by the main ASF 37 is also not possible, and  
5 the recording medium is fed from the side of the sheet discharge rollers 31, 32 toward the sheet conveying roller 21, utilizing the straight sheet path. The functions of the auto both-side unit 2 in such case will be explained in the following.

10 Figs. 14A and 14B are schematic lateral cross-sectional views showing functions of the switching flap 104. Fig. 14A shows a state in an auto both-side recording with an ordinary recording sheet (recording medium) as explained in the foregoing. In  
15 this state, the switching flap spring 105 biases and maintains the switching flap 104 in contact with a stopper against the pressure of the recording sheet 4, so that the recording sheet 4 is guided to the aforementioned sheet path for inversion.

20 Fig. 14B shows a state of using a recording medium of a high rigidity. The highly rigid recording medium 4', upon entering the auto both-side unit 2, passes under the exit flap 106 and impinges on the switching flap 104. Since the switching flap  
25 spring 105 is adjusted at such a load that the switching flap 104 can rock in a retracting direction upon being pressed by the inserted highly rigid

recording medium 4', the switching flap 104 rocks counterclockwise and is moved to a retracted position with the advancement of the highly rigid recording medium 4'. Therefore, the highly rigid recording  
5 medium 4' is guided to a shunt path 131 constituting a second sheet path and provided between the both-side roller A 108 and the both-side roller B 109. The rear cover 103 has an aperture in a position corresponding to the shunt path 131, so that the  
10 highly rigid recording medium 4' even of a large length is not hindered in conveying by an interference with the auto both-side unit 2.

The present invention is not limited to the aforementioned configuration, explained with  
15 reference to Fig. 14B. In executing the present invention, it is not essential to form a shunt path 131 between the two both-side rollers at above and below, but there can also be adopted a following configuration.

20 Fig. 22 is a schematic cross-sectional view showing an auto both-side unit 2 of a variation in which a both-side roller of a large diameter is positioned above a substantially horizontal path. Referring to Fig. 22, a switching flap 104 is biased,  
25 by an unillustrated switching flap spring, in a position shown in Fig. 11, and such switching flap spring is adjusted at such a spring force (pressing

force) that the switching flap 104 is rotated when contacted by a highly rigid recording medium. In Fig. 22, components corresponding to those in Figs. 13, 14A and 14B are represented by corresponding numbers and the details thereof will refer to the foregoing description and will not be explained further.

Therefore, the recording sheet of low rigidity proceeds in a direction indicated by an arrow a in Fig. 22 by the rotation of the both-side roller A 108 in a direction indicated by an arrow c in Fig. 22, but the recording medium of a high rigidity pushes away the switching flap 104 and proceeds into a shunt path 131 as indicated by an arrow b in Fig. 22. Therefore, a highly rigid recording medium even of a large length is not hindered in conveying by an interference with the auto both-side unit 2.

As explained in the foregoing, in the auto both-side unit of the present embodiment, it is possible to execute a one-side recording on a recording medium which has a high rigidity and cannot be bent much, without detaching the auto both-side unit.

The auto both-side unit 2 having two sheet paths has been explained in the foregoing.

In the following, there will be explained a drive mechanism for the rollers of the auto both-side unit 2.

Fig. 15 is a schematic lateral cross-sectional view showing a roller driving mechanism of the auto both-side unit 2, seen from a side opposite to that of Fig. 2, in an embodiment of the recording apparatus of the present invention.

Referring to Fig. 15, there are shown a both-side transmission gear train 115 for transmitting power from the LF motor 26 to a both-side solar gear 116, a both-side solar gear 116 positioned at a center of a both-side pendulum arm, a both-side pendulum arm 117 capable of rocking about the both-side solar gear 116, a both-side planet gear A 118 mounted rotatably on the both-side pendulum arm 117 and meshing with the both-side solar gear 116, and a similar both-side planet gear B 119.

Referring to Fig. 15, there are also shown a spiral groove gear 120 engaging with the both-side solar gear 116 through an idler, an inversion delay gear A 121 meshing with the both-side planet gear B 119, an inversion delay gear B 122 concentric with the inversion delay gear A, an inversion delay gear spring 123 providing a relative biasing force between the inversion delay gear A 121 and the inversion delay gear B 122, a both-side idler gear 124 connecting the two both-side roller gears, a both-side roller gear A 125 fixed to the both-side roller A 108, a both-side roller gear B 126 fixed to the



both-side roller B 109, a stop arm 127 rocking by  
engaging with the groove of the spiral groove gear  
120, a stop arm spring 128 for centering the stop arm,  
and a both-side pendulum arm spring 132 mounted on  
5 the both-side pendulum arm 117.

In the present embodiment, as explained in the  
foregoing, the driving power for the auto both-side  
unit 2 is obtained from the LF motor 26 which drives  
the sheet conveying roller 21. Such configuration is  
10 preferred since, in conveying the recording sheet by  
the cooperation of the sheet conveying roller 21 and  
the both-side roller A 108 or B 109, an almost  
complete synchronization can be achieved in  
start/stop timing or in the conveying speed of the  
15 recording sheet.

A driving force from the LF motor 26 is  
transmitted to the both-side solar gear 116 through  
the both-side transmission gear train 115. On the  
both-side solar gear 116, there is mounted the both-  
20 side pendulum arm 117, on which the both-side planet  
gear A 118 and the both-side planet gear B 119 are  
mounted.

As a suitable frictional force is provided  
between the both-side solar gear 116 and the both-  
25 side pendulum arm 117, the both-side pendulum arm 117  
causes a rocking motion along the rotation of the  
both-side solar gear 116. Now let it be assumed that

a normal direction means a rotating direction of the LF motor 26 for causing the sheet conveying roller 21 to rotate in a direction to convey the recording sheet in the discharging direction, and that a  
5 reverse direction means a rotating direction of the LF motor 26 for conveying the recording sheet toward the auto both-side unit 2. When the LF motor 26 is rotated in the normal direction, the both-side solar gear 116 rotates in a direction indicated by an arrow  
10 a in Fig. 15. Along with the rotation of the both-side solar gear 116, the both-side pendulum arm 117 basically rocks in a direction of the arrow a in Fig. 15.

As a result, the both-side planet gear A 118  
15 meshes with the both-side roller idler gear 124, thereby rotating the both-side roller idler gear 124. By the rotation of the both-side roller idler gear 124, the both-side roller gear A 125 rotates in a direction of an arrow c in Fig. 15, while the both-  
20 side roller gear B 126 rotates in a direction of an arrow d in Fig. 15. The arrows c and d in Fig. 15 correspond to directions in which the both-side roller A 108 and the both-side roller B 109 respectively convey the recording sheet in the auto  
25 both-side unit 2.

When the LF motor 26 is rotated in the reverse direction, the both-side solar gear rotates in a

direction of an arrow b in Fig. 15. With the rotation of the both-side solar gear 116, the both-side pendulum arm basically rocks in a direction of an arrow b in Fig. 15, whereupon the both-side planet gear B 119 meshes with the inversion delay gear A 121. The inversion delay gear A 121 and the inversion delay gear B 122 respectively have projections, which protrude from mutually opposed thrust faces and which mutually engage as a clutch when the inversion delay gear A 121 is rotated by one turn while the inversion delay gear B 122 is stopped.

Prior to the engagement of the both-side planet gear B 119 with the inversion delay gear A 121, the inversion delay gear A 121 and the inversion delay gear B 122 are biased by the inversion delay gear spring 123 in such a direction that the projections are mutually separated, so that the inversion delay gear B 122 starts to rotate after about a turn of the inversion delay gear A 121 from the start of rotation thereof. Consequently, a period from the start of rotation of the LF motor 26 in the reverse direction, to the start of rotation of the inversion delay gear B 122 constitutes a delay period, in which the both-side roller A 108 and the both-side roller B 109 remain in a stopped state.

A rotation of the inversion delay gear B 122 causes, through the both-side roller idler gear 124,

the both-side roller gear A to rotate in a direction of the arrow c in Fig. 15 and the both-side roller gear B to rotate in a direction of the arrow d in Fig. 15. These rotating directions are same as those when the LF motor 26 is rotated in the normal direction. Therefore, this mechanism allows to rotate the both-side roller A 108 and the both-side roller B 109 constantly in the conveying direction of the recording sheet, regardless of the rotating direction of the LF motor 26.

In the following, there will be explained the function of the spiral groove gear 120. The spiral groove gear 120 is provided with gear teeth on the external periphery and, and, on an end face, with a cam formed by a spiral groove having an endless track at the innermost circumference and at the outermost circumference. In the present embodiment, the spiral groove gear 120 is connected with the both-side solar gear 116 across the idler gear, and therefore rotates in the same direction as and in synchronization with the both-side solar gear 116. In the groove of the spiral groove gear 120, there engages a follower pin 127a constituting a part of the stop arm 127, which therefore rocks according to the rotation of the spiral groove gear 120. For example, when the spiral groove gear 120 rotates in a direction of an arrow e in Fig. 15, the follower pin 127a is guided in the

spiral groove and is drawn into the internal part,  
whereby the stop arm 127 rocks in a direction of an  
arrow g in Fig. 15. In case the spiral groove gear  
120 continues to rotate in the direction of the arrow  
5 e in Fig. 15, the follower pin 127a soon enters the  
endless track at the innermost circumference, whereby  
the rocking motion of the stop arm 127 stops at a  
predetermined position.

On the other hand, in case the spiral groove  
10 gear 120 rotates in a direction of an arrow f in Fig.  
15, the follower pin 127a is moved to the outer  
circumference whereby the stop arm 127 rocks in a  
direction indicated by an arrow h in Fig. 15.  
Similarly also in this case, when the spiral groove  
15 gear 120 continues to rotate in the direction of the  
arrow f in Fig. 15, the follower pin 127a soon enters  
the endless track at the outermost circumference,  
whereby the rocking motion of the stop arm 127 stops  
at a predetermined position. In order that the  
20 follower pin 127a can smoothly move from the  
outermost or innermost endless track to the spiral  
groove when the rotating direction of the spiral  
groove gear 120 is changed, a stop arm spring 128 is  
mounted on the stop arm 127 for causing a centering  
25 force to a center position at about the middle of the  
moving range of the stop arm 127.

The stop arm 127 functioning as explained above

acts on the both-side pendulum arm spring 132 mounted on the both-side pendulum arm 117. The both-side pendulum arm spring 132 is an elastic member mounted on the both-side pendulum arm 117 and extending  
5 toward the stop arm 127. The front end of the both-side pendulum arm spring 132 is always positioned closer than the stop arm 127 to the center of the spiral groove gear 120.

Such configuration provides following functions  
10 when the LF motor 26 rotates in the normal direction. When the recording sheet is conveyed to the auto both-side unit 2 by rotating the LF motor 26 in the reverse direction and is returned to the sheet conveying roller 21 after the front-back side  
15 inversion, the stop arm 127 is in such a state where the follower pin 127a thereof rotates on the outermost endless track of the spiral groove gear 120. Therefore, during the recording on the back side by rotating the LF motor 26 in the normal direction, the  
20 follower pin 127a of the stop arm 127 moves toward the internal circumference of the spiral groove gear 120. When the LF motor 26 rotates in the normal direction, since the both-side pendulum arm 117 executes power transmission by a rocking in the  
25 direction of the arrow a in Fig. 15, the stop arm 127 comes into contact with the both-side pendulum arm spring 132 in the course of movement of the stop arm .

127 toward the internal circumference.

When the LF motor 26 is further rotated in the normal direction, the stop arm 127 moves further to the internal circumference thereby causing an elastic  
5 deformation of the both-side pendulum arm spring 132, whereby the position of the both-side pendulum arm 117 is determined by a balance of a force, acting in an angular direction of pressure, of the meshing  
10 tooth faces of the both-side planet gear A 118 and the both-side roller idler gear 124 in mutually meshing state, a force for rocking the both-side pendulum arm 117 in the direction of the arrow a in Fig. 15, and a repulsive force of the both-side pendulum arm spring 132. In the present embodiment,  
15 the repulsive force of the both-side pendulum arm spring 132 is selected so small that, even when the stop arm 127 is present in the innermost endless track, the power transmission between the both-side planet gear A 118 and the both-side roller idler gear  
20 124 is continued with a mere elastic compression of the both-side pendulum arm spring 132.

Also, even in case the operation of the LF motor 26 is intermittent and repeats rotation and stopping, teeth of the both-side planet gear A 118 and  
25 the both-side roller idler gear 124 continue to mesh and are not disengaged even during a stopped state. However, when the recording on the back side of the

recording sheet 4 is completed and the power transmission to the auto both-side unit 2 becomes unnecessary, it is preferable to disconnect the drive in order to reduce the load on the LF motor 26.

5 Therefore, following operations are executed in case of disconnecting the power transmission.

More specifically, the LF motor 26 is slightly rotated in the reverse direction, in a state where the stop arm 127 is in the innermost endless track  
10 and the both-side pendulum arm spring 132 is elastically deformed. In this operation, while the both-side pendulum arm 117 is in a state of receiving a rotating force in a direction of an arrow b in Fig. 15 by the repulsive force of the both-side pendulum  
15 arm spring 132 but being stopped by the mutual meshing of the teeth of the both-side planet gear A 118 and the both-side roller idler gear 124, a rotation in a direction of disengaging the mutual meshing of the teeth is given in such state, whereby  
20 the both-side pendulum arm 117 rotates at once in a direction of an arrow b in Fig. 15.

Once the both-side pendulum arm 117 is rotated in the direction of the arrow b in Fig. 15 as explained above, the elastically deformed both-side  
25 pendulum arm spring 132 returns to the original state. Therefore, even in case the LF motor 26 is rotated in the normal direction in this state, because of the



interference of the both-side pendulum arm spring 132 and the stop arm 127, the both-side pendulum arm 117 cannot cause a rocking motion to a position where the both-side planet gear A 118 and the both-side roller idler gear 124 mutually mesh. Therefore, from this state, the driving power cannot be transmitted to the both-side pendulum arm 117 and the subsequent components in the auto both-side unit 2 unless the LF motor 26 is rotated in the reverse direction by a predetermined amount. The drive up to the both-side pendulum arm 117 merely involves rotation of a gear train and only requires a little load on the LF motor 26, almost comparable to that when the auto both-side unit 2 is not attached.

15           In case the LF motor 26 is rotated in the reverse direction from a state where the stop arm 127 is in the innermost endless track, the power transmission to the inversion delay gear A 121 can be executed as explained before, since there is no effect between the both-side pendulum arm spring 132 and the stop arm 127.

The drive mechanism for the rollers of the auto both-side unit 2 has been explained in the foregoing.

25           Figs. 16A, 16B, 16C, 16D, 16E and 16F are schematic lateral cross-sectional views of the drive mechanism for the rollers of the auto both-side unit 2 shown in Fig. 15, in respective function states.

Also Figs. 20A and 20B are flow charts showing an operation sequence of an auto both-side recording.

In the following, details of the function of the roller driving mechanism of the auto both-side unit 2 and of the function of auto both-side recording will be explained with reference to a flow chart in Figs. 20A and 20B.

When an auto both-side recording is initiated, a step S1 executes feeding of a recording sheet 4. For example the recording sheet 4 is fed from the main ASF 37 toward the sheet conveying roller 21. Then a step S2 executes a recording of a front (top) side. This operation is similar to a one-side recording. In this operation, the roller drive mechanism is in a state shown in Fig. 16A.

Fig. 16A shows a state where the LF motor 26 rotates in the normal direction after an initialization of the drive mechanism of the auto both-side unit 2. This corresponds to a state during a front side recording operation in an auto both-side recording, or during an ordinary recording operation not utilizing the auto both-side recording. The follower pin 127a of the stop arm 127 is in the innermost endless track of the spiral groove gear 120, whereby the both-side pendulum arm 117 tends to rock in the direction of the arrow a in Fig. 15 but impinges on the stop arm 127 and cannot rock any more,

so that the both-side planet gear A 118 cannot mesh with the both-side roller idler gear 124, and the driving power from the LF motor 26 is not transmitted to the both-side roller gear A 125 nor the both-side  
5 roller gear B 126. In this state, the both-side roller A 108 or the both-side roller B 109 subjected to an axial loss under the pressure of the both-side pinch roller A 112 or the both-side pinch roller B 113 is not rotated, so that the load to the LF motor  
10 26 is low.

Then, when the recording on the front side is completed, a step S3 confirmed whether the rear end of the recording sheet has been detected by the PE sensor 67. In case the PE sensor 67 still detects  
15 the presence of the recording sheet 4, the rear end of the front side thereof is not yet detected and a step S4 continues the rotation of the LF motor 26 in the normal direction to move the recording sheet 4 until the rear end of the front side thereof reaches  
20 a position p2 a little beyond the PE sensor lever 66. Then a step S5 calculates the length of the recording sheet 4, based on the conveying amount of the recording sheet 4 from the detection of the front edge of the front side of the recording sheet 4 to  
25 the detection of the rear edge by the PE sensor 67.

As explained in the foregoing, a recording sheet 4 having a length shorter than a predetermined

length L1 has to be excluded from the auto both-side recording operation, since the front edge of the recording sheet 4 cannot reach the roller in the conveying from the sheet conveying roller 21 to the both-side roller B 109 or in the conveying from the both-side roller 108 to the sheet conveying roller 21. Also a recording sheet 4 having a length longer than a predetermined length L2 has to be excluded from the auto both-side recording operation, since the recorded surface of the recording sheet causes an undesirable mutual contact in the sheet path from the sheet conveying roller 21 to the auto both-side unit 2. In case a necessity for exclusion from the auto both-side recording operation is identified under these conditions, the flow proceeds to a step S6 for rotating the LF motor 26 in the normal direction thereby directly discharging the recording sheet 4 and issuing an alarm for a sheet feed error. In case the length of the recording sheet is identified as suitable for the both-side recording under the aforementioned conditions, the flow proceeds to a step S7 for shifting the lift mechanisms to the third position thereby releasing the pinch roller 22.

Then a step S8 confirms whether the rear end of the front side of the recording sheet 4 has already been conveyed to a downstream side of a position p1 in the vicinity of the pinch roller 22. In case the

conveying has already been made to the downstream side, a step S9 executes a back-feed by rotating the LF motor 26 in the reverse direction until the rear end of the front side reaches p1 in order to achieve  
5 a secure pinching between the sheet conveying roller 21 and the pinch roller 22 when the pinch roller 22 is returned to the contact state. In these operations, the roller drive mechanism is in a state shown in Fig. 16B. It is preferred not to interrupt  
10 the steps S2 to S8 as far as possible and to execute the step S9 before the recording sheet 4 is deformed, as explained before. In case the rear end of the front side is at an upstream side of p1, a secure pinching of the recording sheet is possible by  
15 contacting the pinch roller 22, so that the flow immediately proceeds to a step S10.

Fig. 16B shows a state immediately after the start of rotation of the LF motor 26 in the reverse direction. This state is assumed immediately after  
20 the start of the back-feed, after the completion of the front-side recording in the auto both-side recording, or in case the LF motor 26 is rotated in the reverse direction for the purpose of regulating a lead-in amount after the sheet feeding from the main  
25 ASF 37. In this state, the rocking motion of the both-side pendulum arm 117 in the direction of the arrow b in Fig. 15 is not hindered, so that the both-

side planet gear B 119 meshes with the inversion  
delay gear A 121. In response, the inversion delay  
gear A 121 starts to rotate, but does not transmit,  
for about a turn, the driving power to the inversion  
5 delay gear B 122, whereby the both-side roller idler  
gear 124 does not rotate and the both-side roller A  
108 and the both-side roller B 109 do not function.

Therefore, the load to the LF motor 26 is still  
low in this state. Such state is provided because,  
10 at the back-feeding of the recording sheet 4 in the  
auto both-side recording operation, the both-side  
roller B 109 need not be rotated until the front edge  
of the recording sheet 4 reaches the both-side roller  
B 109 since there is a certain distance from the  
15 sheet conveying roller 21 to the both-side roller B  
109. It is also possible, for example at the  
regulation of the lead-in amount in the ordinary  
recording operation, to avoid unnecessary rotation of  
the both-side roller A 108 or the both-side roller B  
20 109 as explained before.

Then a step S10 provides a waiting time until  
the ink recorded on the front side of the recording  
sheet 4 dries. Since the necessary drying time is  
variable by certain factors as explained before, the  
25 waiting time  $t_1$  for drying may be made a variable  
parameter. More specifically,  $t_1$  is determined in  
consideration of conditions such as a type of the

recording sheet, a type of the ink, a superposed  
deposition method of the ink, an ink deposition  
amount per unit area, an environmental temperature,  
an environmental humidity, and an environmental air  
5 flow rate.

Then a step S11 shifts the lift mechanisms to a  
fourth position, whereby the recording sheet 4 is  
pinched again by the sheet conveying roller 21 and  
the pinch roller 22.

10 Then a step S12 provides a waiting time  $t_2$  for  
drying. It may be dispensed with in case the waiting  
for a time  $t_1$  is executed in the step S10, and, in  
such case, the flow may proceed to a next step,  
assuming  $t_2 = 0$ . The waiting of a time  $t_2$  for drying  
15 is required in case a rear end portion of the  
recording sheet 4 is not subjected to a recording  
operation and constitutes a margin. In such case,  
the pinch roller 22 can be immediately pressed to  
such margin without any trouble, by taking  $t_1 = 0$  in  
20 the step S10. However, an immediate back-feed of the  
recording sheet 4 may cause a transfer of the undried  
ink onto the pinch roller 22, and a waiting time  $t_2$   
for drying may be provided in the step S12.

Then a step S13 rotates the LF motor 26 in the  
25 reverse direction, thereby back-feeding the recording  
sheet 4 by a predetermined amount  $X_1$ . This step  
conveys the recording sheet 4 to the auto both-side

unit 2 for front-back side inversion. After this step, a front edge of the back side returns to a position slightly in front of the sheet conveying roller 21. At this point, the roller drive mechanism  
5 assumes a state shown in Fig. 16C.

Fig. 16C shows a state where the LF motor 26 continues to rotate in the reverse direction. This corresponds to a state where the recording sheet 4 is back-fed and inverted in the auto both-side unit 2.  
10 When the inversion delay gear A 121 rotates by about a turn after the state shown in Fig. 16B, the projection protruding in the thrust direction of the inversion delay gear A 121 engages with the opposed projection of the inversion delay gear B 122, whereby  
15 the inversion delay gear A 121 and the inversion delay gear B 122 start to integrally rotate. Since the inversion delay gear B 122 constantly engages with the both-side roller idler gear 124, the rotation of the inversion delay gear B 122 causes the  
20 both-side roller idler gear 124, the both-side roller gear A 125 and the both-side roller gear B 126 to rotate. Thus the both-side roller A 108 rotates in a direction of an arrow c in Fig. 15, while the both-side roller B 109 rotates in a direction of an arrow  
25 d in Fig. 15.

Now there will be explained so-called registration operation in case the front edge of the



back side is introduced into the nip between the sheet conveying roller 21 and the pinch roller 22. At first, a step S14 switches the control according to whether the currently employed recording sheet 4  
5 is a thin sheet of a low rigidity or a thick sheet of a high rigidity. The rigidity of the recording sheet 4 may be judged for example by the kind of the recording sheet set by the user for example in a printer driver, or by detection means for measuring  
10 the thickness of the recording sheet 4. The control is divided into two kinds because the recording sheet 4 shows different behaviors depending on the rigidity, when it is bent to form a loop.

At first there will be explained a case of a  
15 thin recording sheet 4 of a relatively low rigidity. Figs. 18A, 18B and 18C are schematic lateral cross-sectional views showing registration of the front edge of the back side in case of employing a thin recording sheet 4. Referring to Figs. 20, 18A, 18B  
20 and 18C. the rotation of the LF motor 26 in the reverse rotation in the step S13 executes inverted conveying of the sheet shown in Fig. 18A. After the step S13, the front edge of the back side of the recording sheet 4 almost returns to the vicinity of  
25 the sheet guide 70. In case of a thin recording sheet 4, the flow proceeds then to a step S15. The step S15 shifts the lift mechanisms to the first

position, thereby elevating the sheet guide 70.

Fig. 18B shows a state after the end of the step S15. As the center of the pinch roller 22 is somewhat offset to the side of the first sheet discharge roller 30 with respect to the center of the sheet conveying roller 21 as explained before, the nip between the sheet conveying roller 21 and the pinch roller 22 has a certain angle with respect to the substantially horizontal direction in which the recording sheet 4 is conveyed. By returning the sheet guide 70 to the elevated position prior to the registration, it is rendered possible to smoothly guide the front edge of the back side of the recording sheet 4 into such inclined nip portion.

Then a step S16 rotates the LF motor 26 in the reverse direction, thereby further conveying the recording sheet 4 toward the sheet conveying roller 21. Then a step S17 detects the front edge of the back side of the recording sheet 4 by the PE sensor 67. Upon detection of the front edge of the back side, the flow proceeds to a step S18.

Then a step S18 conveys the recording sheet 4 by a distance X2 slightly longer than a distance from a detecting position for the front edge of the back side by the PE sensor 67 to the sheet conveying roller 21. Through this operation, the front edge of the back side of the recording sheet 4 reaches the

nip portion between the sheet conveying roller 21 and the pinch roller 22, and is bent by an additional conveying thereby forming a loop. Fig. 18C shows a state after the end of the step S18. The elevated  
5 position of the sheet guide 70 reduces the space of the sheet path in the direction of height, but the loop can be easily formed because of the relatively low rigidity of the recording sheet 4 and acts to push the recording sheet, whereby the front edge of  
10 the back side of the recording sheet 4 follows the nip portion between the sheet conveying roller 21 in reverse rotation and the pinch roller 22 and becomes parallel to the sheet conveying roller 21, thus completing so-called registration operation. Then a  
15 step S19 changes the LF motor 26 to the rotation in the normal direction thereby pinching the front edge of the back side of the recording sheet 4 in the nip portion and executing a conveying by a predetermined distance X3, thus completing a preparation for  
20 starting the recording on the back side.

In the following, there will be explained a case of a thick recording sheet 4 of a relatively high rigidity. Figs. 19A, 19B and 19C are schematic lateral cross-sectional views showing registration of  
25 the front edge of the back side in case of employing a thick recording sheet 4. Fig. 19A shows a state in the course of a step S13 as in Fig. 18A, and Fig. 19B

shows a state after the end of the step S13.

Then a step S20, while maintaining the sheet guide 70 in the lowered position, rotates the LF motor 26 in the reverse direction, thereby conveying  
5 the recording sheet 4 by a distance X4 slightly longer than a distance from the position of the front edge of the back side of the recording sheet 4 at the end of the step S13 to the nip of the sheet conveying roller 21. Thus, as in the case of the thin  
10 recording sheet 4, the front edge of the back side of the recording sheet 4 reaches the nip portion of the sheet conveying roller 21 rotated in the reverse direction, and the recording sheet is further advanced to form a loop therein, whereby the front  
15 edge of the back side of the recording sheet 4 becomes parallel to the sheet conveying roller 21 and thus completing the registration operation. Fig. 19C shows a state at the completion of the step S20.

Then a step S21 changes the LF motor 26 to the  
20 rotation in the normal direction thereby pinching the front edge of the back side of the recording sheet 4 in the nip portion and executing a conveying by a predetermined distance X3, thus completing a preparation for starting the recording on the back  
25 side. In the step S19 or S21, the LF motor 26 which has rotated in the reverse direction changes the rotation to the normal direction. At this point, the

both-side pendulum arm 117 rocks to a direction indicated by an arrow a in Fig. 15. In response, the both-side planet gear B 119 and the inversion delay gear A 121 are disengaged. At the reverse rotation  
5 of the LF motor 26, as explained before, the inversion delay gear A 121 and the inversion delay gear B 122 are in a state mutually engaging by projections thereof, and the inversion delay gear spring 124, which is a torsion coil spring sandwiched  
10 between the two, is compressed. Thus, when the inversion delay gear A 121 is freed, the inversion delay gear spring 124 extends and the inversion delay gear A 121 rotates by about a turn in the reverse direction thereby returning to the initial state.

15       Then a step S22 shifts the lift mechanisms to the first position, thus completing the preparation for starting the recording of the back side. Now there will be explained reason why the sheet guide 70 is maintained in the lowered state during the  
20 registration operation with the thick recording sheet 4. In case of trying to generate a loop in the same manner as in the thin recording sheet 4 as shown in Fig. 18C, the recording sheet 4, because of its high rigidity, is conveyed along the pinch roller holder  
25 23 even before arriving at the nip portion of the sheet conveying roller 21. Therefore, in case of executing an additional conveying for forming a loop

after the recording sheet 4 arrives at the nip portion, there is no space for loop formation and the loop cannot be formed. Therefore, a satisfactory registration may not be achievable.

5           Also in case a loop is not formed, the recording sheet 4 has no slack (bend) in the state simultaneously supported by the both-side roller A 108 and the sheet conveying roller 21. In case the drive mechanism for the both-side rollers employs a  
10 mechanism such as a both-side pendulum arm 117 as in the present embodiment, when the LF motor 26 is rotated in the normal direction in the step S21 after the LF motor 26 is rotated in the reverse direction in the step S20, there is required a period for  
15 rocking of the both-side pendulum arm 117 before the both-side roller A 108 and the both-side roller B 109 are rotated, and the both-side roller A 108 and the both-side roller B 109 remain stopped during such period.

20           The sheet conveying roller 21, being directly connected to the LF motor 26, has no such stopping period, thus generating a contradiction in the sheet conveying speed. If the recording sheet 4 has a slack, the contradiction in the sheet conveying speed  
25 can be absorbed by taking up such slack of the recording sheet 4 when the sheet conveying roller alone is rotated in the step S21. In the absence of

such slack, the contradiction in the sheet conveying speed cannot be absorbed and the sheet conveying roller 21 forcedly tries to convey the recording sheet 4, but there may result a situation where the recording sheet 4 is not actually conveyed because it is pinched in a rear portion by the both-side roller A 108. Such situation may result in an erroneous conveying amount of the front edge portion of the back side of the recording sheet 4, thus providing an upper margin, on the back side, shorter than an intended value. In the present embodiment, in order to avoid the aforementioned drawbacks, the sheet guide 70 is maintained in the lowered state, thereby forming a sufficient space in the height to the pinch roller holder 23 and securing a loop forming space. It is thus rendered possible to achieve satisfactory registration even in case of using a thick recording sheet 4 of a relatively high rigidity.

Then a step S23 executes a recording operation on the back side of the recording sheet 4. At this moment, the rear end portion of the back side of the recording sheet 4 is still pinched by the both-side roller A 108 in most cases. It is undesirable to stop the rotation of the both-side roller A 108 immediately since it may become a load for pulling the recording sheet 4 backward, thus deteriorating the precision of the sheet conveying. Therefore, the

drive of the both-side roller A 108 is continued at least while the rear end portion of the back side of the recording sheet 4 is pinched by the both-side roller A 108. A state of the drive mechanism for the  
5 both-side rollers is shown in Fig. 16D.

Fig. 16D shows a state of the drive mechanism for the rollers of the auto both-side unit 2 while the LF motor 26 is rotated in the normal direction after the inversion of the recording sheet 4. When  
10 the rotation of the LF motor 26 is changed to the normal direction from the state shown in Fig. 16C, the both-side pendulum arm 117 rocks in a direction of an arrow a in Fig. 15. In this state, since the stop arm 127 is rocking in a direction of an arrow h  
15 in Fig. 15, the both-side pendulum arm spring 132 does not contact the stop arm 127 when the both-side pendulum arm 117 rocks in the direction of the arrow a in Fig. 15, whereby the both-side planet gear A 118 engages with the both-side roller idler gear 124 to  
20 achieve transmission of the driving power.

When the LF motor 26 continues to rotate in the normal direction thereafter, the follower pin 127a is guided by the spiral groove gear 120 and moves toward the internal circumference, whereby the stop arm 127  
25 rocks in a direction of an arrow g in Fig. 15. In the course of such rocking motion, the stop arm 127 contacts the both-side pendulum arm spring 132



thereby causing a deformation thereof. The deformation of the both-side pendulum arm spring 132 generates a repulsive force acting to rock the both-side pendulum arm 117 in the direction of the arrow b in Fig. 15, but, during the transmission of the driving power between the both-side planet gear A 118 and the both-side roller idler gear 124, a force generated by meshing of the teeth thereof is stronger, whereby the both-side planet gear A 118 and the both-side roller idler gear 124 are not disengaged and continue the drive. Fig. 16D shows such state.

Also in case of an intermittent drive involving rotation and stopping, the both-side planet gear A 118 and the both-side roller idler gear 124 are not disengaged because of the meshing of the gear teeth. When the recording operation on the back side of the recording sheet 4 is continued by the normal rotation of the LF motor 26, the follower pin 127a reaches the innermost circumference of the spiral groove gear 120. Fig. 16E shows the drive mechanism for the both-side rollers in such state. In this state, the both-side pendulum arm spring 132 shows a maximum displacement, but, since the load of the both-side pendulum arm spring 132 is so selected that the force generated by the meshing of the gear teeth becomes larger than the force for rocking the recording sheet both-side arm 117, the gears are not disengaged as long as the LF

motor 26 continues to rotate in the normal direction. When the recording operation on the back side of the recording sheet 4 is completed, the flow proceeds to a step S24.

5           Then a step S24 executes a sheet discharging operation of discharging the recording sheet 4 onto an unillustrated discharge tray. The sheet discharging operation can be executed by continuing the rotation of the LF motor 26 in the normal  
10 direction, thereby conveying the recording sheet 4 by the second sheet discharge roller 31 to the exterior of the main body 1 of the recording unit.

          Then a step S25 executes a confirmation of an absolute position of the front edge of the back side.  
15 This operation is executed because the follower pin 127a may not have reached the innermost circumference of the spiral groove gear 120 in case of a short recording sheet 4. In such situation, the LF motor 26 is rotated corresponding to a predetermined length,  
20 whereby the follower pin 127a is always brought to the innermost circumference of the spiral groove gear 120 when the back side recording operation for the recording sheet 4 is completed.

          Then a step S26 executes an initialization of  
25 the drive mechanism for the both-side rollers. As the both-side pendulum arm spring 132 is maintained in a charged state by the engagement of the both-side

planet gear A 118 and the both-side roller idler gear 124, they can be easily disengaged by a little rotation of the LF motor 26 in the reverse direction. More specifically, in response to a rotation of the LF motor 26 in the reverse direction, the both-side pendulum arm 117 tends to rock in a direction of an arrow b in Fig. 15, whereby the both-side planet gear A 118 and the both-side roller idler gear 124 are disengaged and the both-side pendulum arm 117 rocks at once in the direction of the arrow b in Fig. 15, by a returning force of the charged both-side pendulum arm spring 132. Fig. 16F shows the drive mechanism for the both-side rollers at such state.

In case the LF motor 26 is rotated in the normal direction in this state where the both-side pendulum arm spring 132 has returned to the original state, the both-side pendulum arm 117 tends to rock in a direction of an arrow a in Fig. 15 but, since the follower pin 127a is positioned in the vicinity of the innermost circumference of the spiral groove gear 120, the both-side pendulum arm spring 132 impinges on the stop arm 127 and the both-side planet gear A 118 cannot engage with the both-side roller idler gear 124. Even if the LF motor 26 is further rotated in the normal direction, the follower pin 127a continues to rotate on the innermost circumference of the spiral groove gear 120, so that

the both-side roller A 108 and the both-side roller B 109 cannot be driven. Also as the inversion delay gear A 121 is already initialized in the step S19 or S21, the step S26 completes the initialization of the  
5 drive mechanism for all the both-side rollers.

Thus the auto both-side recording operation is terminated. A same sequence is repeated in case of executing an auto both-side recording operation in continuation.

10 In the present embodiment, an elastic impingement is realized between the both-side pendulum arm 117 and the stop arm 127 by the function of the both-side pendulum arm spring 132, but the present invention is not limited to such  
15 configuration and may also be constructed as follows.

Figs. 17A, 17B, 17C, 17D and 17E are schematic perspective views showing a roller drive mechanism of the auto both-side unit 2 constituting a variation of that shown in Figs. 16A, 16B, 16C, 16D, 16E, 16E and  
20 16F. A both-side pendulum arm 117 shown in Figs. 17A, 17B, 17C, 17D and 17E is provided with an arm of a low elasticity, and such arm and the stop arm are so arranged as to mutually impinge. Functions in this configuration will be briefly explained in the  
25 following.

Functions from Figs. 17A to 17C are similar to those shown in Figs. 16A to 16C and will not,

therefore, be explained further.

Fig. 17D shows a state where the stop arm 127 has moved toward the internal circumference of the spiral groove gear 120 and impinges on the arm of the both-side pendulum arm 117. When the arm of the both-side pendulum arm 117, not having much elasticity, is pushed by the stop arm 127, exerts a force to rock the both-side pendulum arm 117 in a direction of an arrow b in Fig. 15 on the both-side pendulum arm 117. Such force acts in a direction to disengage the both-side planet gear A 118 and the both-side roller idler gear 124.

Such disengaging force is balanced with a pressure between the teeth of the both-side planet gear A 118 and the both-side roller idler gear 124 and an elastic and sliding force of such gear teeth, but the disengaging force becomes larger as the follower pin 127a moves toward the internal circumference and overcomes the forces between the gear teeth, thereby forcedly disengaging the both-side planet gear A 118 and the both-side roller idler gear 124. The rotation of the both-side roller A 108 and the both-side roller B 109 is stopped simultaneously with the disengagement. This state is shown in Fig. 17E. Such stopping of the roller rotation is executed at a suitable timing, in the step S23, after the rear end of the back side of the

recording sheet 4 has passed the both-side roller A 108.

After the disengagement of the gears, the both-side pendulum arm 117 is prevented from rocking in the direction of the arrow a in Fig. 15 by the stop arm 127 even if the LF motor 26 is rotated in the normal direction, so that the auto both-side unit 2 is not driven until the LF motor 26 is next driven in the reverse direction by a predetermined amount.

Also as in the first embodiment, the inversion delay gear A 121 is initialized in the step S19 or S21, so that the initialization of the drive mechanism for the roller of the auto both-side unit 2 is completed at this point. In this manner it is possible to eliminate the loads of rotating the both-side roller A 121 and the both-side roller B 122 during the back side recording operation, thereby alleviating the rotational load of the LF motor 26.

In the foregoing, there has explained a variation of the roller drive mechanism for the auto both-side unit 2.

The present invention is not limited to such configurations, and there may be adopted a control in which the position of the lift mechanisms is changed.

For example, in the foregoing, the sheet guide 70 is in the up-state in a normal waiting state, but it may also be in the down-state. More specifically, there

is employed a configuration of placing the lift mechanisms normally at the third position and adding a control for shifting the lift mechanisms from the third position to the first position prior to the  
5 step S1. There may also be adopted a configuration of adding a control for shifting the lift mechanisms from the first position to the third position after the step S26. Such configuration is suitable for passing a cardboard or the like from the side of the  
10 sheet discharge roller, since the pinch roller 22 is in a released state in the waiting state. In the foregoing, there has been given an explanation on the auto both-side recording operation, with reference to an operation sequence shown in a flow chart.

15 In the foregoing, embodiments have been explained by a serial type recording apparatus in which the recording is executed under a movement of a recording head, constituting recording means, in the main scanning direction, but the present invention is  
20 likewise applicable to and provides similar effects in a line type recording apparatus utilizing recording means of line type of a length covering the entire width of the recording sheet or a part thereof and achieving recording by a sub scanning (sheet  
25 conveying) only.

Also the present invention can be executed regardless of the number of the recording means, and

is likewise applicable to and provides similar effects not only in a recording apparatus utilizing single recording means but also a recording apparatus for color recording, utilizing plural recording means  
5 for inks of different colors, a recording apparatus for gradation recording, utilizing plural recording means for inks of different concentrations of a same color, and a recording apparatus combining these.

Furthermore, in case the recording apparatus is  
10 an ink jet recording apparatus, the present invention is likewise applicable to and provides similar effects in any configuration of a recording head and an ink tank, for example a configuration employing a replaceable head cartridge integrally  
15 containing a recording head and an ink tank, or a configuration in which an recording head and an ink tank are separate and connected with an ink supply tube.

Furthermore, in case the recording apparatus is  
20 an ink jet recording apparatus, the present invention is likewise applicable to and provides similar functions and effects not only in a recording apparatus utilizing an ink jet recording head of a type discharging ink by thermal energy, but also in  
25 the ink jet recording apparatus utilizing other ink discharging process such as a recording apparatus utilizing an ink jet recording head of an ink



discharging process based on an electromechanical converting member such as a piezo element.

In the both-side recording apparatus of the present invention, as explained in the foregoing, a  
5 sheet conveying path for sheet inversion and a sheet path for a recording medium of a high rigidity are commonly shared in a part and both paths can be selectively utilized. Therefore, there can be provided a both-side recording apparatus capable of  
10 passing a recording medium of a large thickness or a high rigidity in a simple configuration without an increase in the dimension of the apparatus and in an attached state of a sheet inversion apparatus, thereby improving the operability.